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Identifying threshold concepts in design

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Identifying
Threshold Concepts in Design

By

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1 Introduction

The research

This portfolio of work is a collection of published papers based upon qualitative research into identifying threshold concepts within undergraduate industrial design, augmented by a commentary. The main body of the research took place at Coventry University between 2005-2010 within the Centre of Excellence for Product and Automotive Design (CEPAD). CEPAD came into being as a result of a successful funding bid to the Higher Education Funding Council for England (HEFCE) under the Centres for Excellence in Teaching and Learning (CETL) initiative (HEFCE 2013).

The overarching theme of the published papers is the journey undertaken in identifying threshold concepts within the undergraduate industrial design programme. This includes the actual identification of a specific threshold concept, the impact of this identification on the programme, and – through publication - the wider impact of the work within both the threshold concept field and the Art and Design discipline.

The main thread of the research focused on a core group of six[1] industrial design students - specifically those undertaking the Transport and Product Design programme - who entered Coventry University in 2005. The students were interviewed approximately twice per year until graduation by myself as Senior Research Assistant for CEPAD.

In addition, qualitative interviews also took place with other transport and product design students as the project progressed. This included the first year intake of 2006, 2008 and 2009 students and also a cohort of international students. In total, eighty-nine industrial design students took part in interviews and/or focus groups over the lifetime of the project, and included undergraduates from years 1 to 4, MSc and PhD students. However, data gathering from the 2005 intake formed the core of the longitudinal study.

[1] This number fluctuated throughout the five years of the project, but six specific students were consistently interviewed from entry to graduation

To underpin the data gathered from students, qualitative data was also gathered from industrial design staff via two whole-staff meetings held in March 2006 and January 2008, and also through a series of one-to-one staff interviews held during the academic year 2005-2006.

The type of interview process used can be characterised as 'conversational' and relates to the 'Interview Guide Approach' in which 'the interviewer has an outline of topics or issues to be covered, but is free to vary the wording and order of the questions to some extent' (Patton, 1990 paraphrased in Sewell, 2013).

In practice, prior to the interviews a set of questions was formulated and then, within the actual interview process (each of which typically took around 30 minutes), the interviewer would, where appropriate, be free to probe for more in-depth responses, which may or may not be directly related to the original questions. However, every attempt was made to ensure that responses to the original questions were obtained.

Context of the portfolio of work

The papers included in this submission have been published both nationally and internationally, and almost all have been peer reviewed. A key theme of the research is the focus on the journey towards, and impact of the identification of, threshold concepts in industrial design. Specifically, the focus is on a threshold concept identified during the research period – 'the toleration of design uncertainty'. This is defined as:

> '…the moment when a student recognises that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process.' (Osmond 2009:132)

When the research began in 2005, there was no evidence to suggest that the threshold concept framework was being applied in the area of design. Therefore, the submissions included as part of this portfolio can be seen as unique contributions in two distinct areas: firstly in the furthering of knowledge within the

threshold concept field, and secondly contributing to the field of pedagogic research methods within industrial design.

In terms of the threshold concept field itself, this body of work adds to threshold concepts which have been identified in many other disciplines. These include depreciation accounting (Lucas and Mladenovic, 2006); caring in health (Clouder, 2005); the concept of the 'other' in communication studies (Cousin, 2006); climate change in geography (Hall, 2011); hypothesis in biology (Taylor et al, 2012); opportunity cost in economics (Shanahan and Meyer, 2006); surface area-to-volume ratio in nano-science (Park and Light, 2010); personhood in philosophy (Cowart, 2010); disjunction and problem-based learning (Savin-Baden, 2000); grammar in language (Orsini-Jones, 2009) and central limit theorem in statistics/entropy in physics (Meyer and Land, 2005).

Turning to the field of pedagogic research in industrial design, the research – specifically the identification of the threshold concept outlined above - builds upon the work of design theorists such as Tovey (incubation period, 1984), Cross (oscillation between problem and solution, 1992), Dorst (tightrope walking, strategic thinking and visionary designer category, 2003); and, of particular interest, Wallace's idea of representing design tasks as a set of 'problem bubbles' (1992). Links were also found in the creativity literature, particularly in the work of Kleiman (creativity as process, 2008), De-Bono (thinking hats, 1995), Baillie (travelling case, 2003) and Amabile (courage to be creative, quoted in Vidal 2009).

The uniqueness of the pedagogic research into threshold concepts in industrial design is further evidenced by the list of published articles categorised under the Design section on the *Threshold Concepts: Undergraduate Teaching, Postgraduate Training and Professional Development* page[2]. This page, hosted by Professor Michael Flanagan - a Teaching Fellow in the Department of Electronic Engineering at UCL - is regarded as the most comprehensive list of articles on the use of threshold concepts within the disciplines.

[2] http://www.ee.ucl.ac.uk/~mflanaga/thresholds.html#indd)

In addition, the CEPAD pedagogic research led directly to the formulation of the Design Research Society (DRS) Special Interest Group (SIG) on Design Pedagogy,[3] which now forms a central part of two international biennial conferences held by the Design Research Society: the DRS biennial conference[4] and DRS Cumulus[5] conference.

Brief details of the portfolio of work

1 An invited, peer reviewed, book chapter for the first in a series of books on the threshold concept theory, which details the initial round of CEPAD research into establishing whether spatial awareness was a threshold concept

2 A peer-reviewed conference proceeding published within the educational research field detailing the progression of the threshold concept research, establishing that spatial awareness was not a threshold concept and identifying the 'confidence to challenge' as being worthy of further research

3 A peer-reviewed conference proceeding published within the Art and Design field identifying the threshold concept as the 'toleration of design uncertainty'

4 An invited, peer reviewed, book chapter for the second in a series of books on the threshold concept theory, which details the research to date and links the identified threshold concept to existing design literature

5 An invited, peer reviewed, Art and Design special edition journal article focusing on the wider CETL project outcomes. This article considered how to offer supportive environments to scaffold the identified threshold concept and how it could contribute to a model of curriculum design.

[3] http://www.designresearchsociety.org/joomla/sig2/sig-desped.html
[4] http://www.designresearchsociety.org/joomla/events/biennial-conf.html)
[5] http://www.cumulusassociation.org

6 A peer-reviewed conference proceeding for the Design Research Society detailing how the identification of the threshold concept led to the development of a pedagogic framework and subsequent revision of the industrial design course

7 A peer-reviewed conference proceeding for the Design Research Society linking the threshold concept theory as a pedagogic research method to the expanding body of pedagogic research within the creative arts

8 An invited book chapter detailing a potential threshold concept linked to professional design identities referencing community of practice theory

9 A peer-reviewed conference proceeding for the Design Research Society detailing how the threshold concept theory can enhance continuing professional development for staff and have a positive impact on teaching and learning practices

10 A peer-reviewed conference proceeding for the Design Research Society detailing how the identified threshold concept can be used to revise thinking around teaching and learning for international MA Design students

2 Aims and objectives of the portfolio of work

The CEPAD project aimed to engage with key themes of teaching and learning within the Coventry University industrial design department and also to wider creative learning environments within the School of Art and Design, the UK and international HE sector.

As outlined in Section 1, the research took place at Coventry University between 2005-2010 and resulted in a final report to HEFCE. As stated in the report:

> 'CEPAD research has led to a pedagogic theory around design as a solution focused activity and a 'dual-processing approach' to design education as transformative practice. To disseminate this understanding and promote a stronger community around design pedagogy it [lead to] two special interest groups of the international Design Research Society (SIGWELL and PEDSIG)…' (Coventry University 2010:18)

The work of CEPAD was also mentioned in the final HEFCE report on the CETLs:

> 'Amongst those CETLs continuing with a clear identity is Coventry University's Centre of Excellence for Product & Automotive Design (CEPAD) whose formal continuation is based on its expanded identity and location which can be described [as] 'an international community of design educators, practitioners and researchers linked to Coventry University'. The centre, based in the specialist facility of the Bugatti Building, encompasses a wide range of design-related activities from developing teaching and learning to research and consultancy.' (HEFCE 2011:147)

After the cessation of the CETL funding stream (2010), CEPAD's role expanded to encompass a wider range of design-related activities and now includes design and ergonomics, design pedagogy, application of biomechanics to design and commercial design activity.

However, this portfolio of work relates to one particular research theme within the CEPAD project – the investigation of the ways in which undergraduate industrial design students acquire, or face difficulty in acquiring, the transformative threshold concepts felt to be crucial for the levels of design practice required by the global transport design community.

The research is framed by Meyer and Land's work (2003) into threshold concepts and troublesome knowledge, which was embedded into the original HEFCE bid by

one of the theory's founders, Professor Ray Land, who at the time was a Research Fellow at Coventry University.

Overall aim

To determine the role and contribution of the threshold concept framework to undergraduate level industrial design education.

Objectives

1 Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2 Identify one or more key threshold concepts in industrial design
3 Relate the threshold concept theory to relevant aspects of design education
4 Relate the threshold concept theory to design theory
5 Relate the emerging constructs to novel design pedagogy arrangements
6 Signal directions for further pedagogic research

In the collection of papers, the objectives are thus addressed:

Submission No.	**Objectives**					
	1	**2**	**3**	**4**	**5**	**6**
1	*					
2	*	*				
3	*	*				
4	*	*	*			
5	*	*		*	*	
6	*	*	*	*	*	*
7			*		*	*
8		*				*
9			*		*	
10						*

To follow is:

- An outline of the theory of the threshold concept framework and its relevance to pedagogic research
- Synopses of the submissions and how they relate to the stated objectives
- A critical reflection on the work
- Conclusion
- Copies of the submissions

3 Threshold concepts

The theory

The notion of the threshold concept framework was introduced and developed by Erik Meyer and Ray Land in 2003 as a result of the Enhancing Teaching and Learning Environments in Undergraduate Courses (ETL) project[6]. Since 2003, the authors have further developed thinking around the theory, discussing its application to course design and assessment (Land *et al*, 2005; Land and Meyer, 2008, 2010; Land and Meyer 2010; Meyer and Land 2003, 2005, 2006; Meyer *et al* 2008).

The threshold concept theory posits the idea that within disciplines there are conceptual gateways or portals, which - due to their troublesome nature – can make it difficult for students to progress. As such, a threshold concept is seen as distinct from the 'core concepts' – or building blocks – within disciplines, due to the notion of transformation (Meyer and Land 2003:6). Therefore, grasping a threshold concept will irrevocably transform a student's understanding, and this transformation can relate to the particular subject at hand, and/or be extrapolated beyond the academy.

Consequently, a threshold concept is seen as a conceptual gateway, and is defined as:

> 'akin to a portal, opening up a new and previously inaccessible way of thinking about something. [It] represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. As a consequence of comprehending a threshold concept there may thus be a transformed internal view of subject matter, subject landscape, or even world view.' (Meyer and Land 2003:1)

Meyer and Land identified several possible characteristics of a threshold concept, and, as outlined above, the first is 'transformation', in that understanding a threshold concept can result in a personal as well as conceptual change. As such this transformation will become part of who the student is, how they see and feel

[6] http://www.etl.tla.ed.ac.uk/project.html

and can expand personal biographies (Cousin, 2006a:4). In essence, students are required to move outside of their comfort zone and enter, sometimes disconcerting, new territories.

Another characteristic is that a threshold concept is often 'irreversible', as once understood the learner is unlikely - and often unable - to forget it.

A threshold concept can also be 'integrative', in that it opens up connections between different learning experiences and enables students to make conceptual leaps within a much wider playing field of knowledge: 'the landscape is different' (Meyer *et al* 2008:70).

Meyer and Land also posit that a threshold concept can be 'bounded', and as such can reside within a discipline as a 'signature pedagogy' and so demarcate academic territories. According to the authors this can be problematic, as it speaks to hierarchies and power relations both within the learning environment and wider academic communities.

But perhaps the most important characteristic of all is that of 'troublesome knowledge': 'knowledge that is conceptually difficult, counter-intuitive or 'alien' ' (Perkins, 1999 in Meyer and Land 2003:1). This is the characteristic that receives the most attention from the authors, and Meyer and Land discuss how previous forms of knowledge need to be challenged in order to master a threshold concept.

Examples given are *ritual* knowledge – that which is routinely offered in response to a question, but which does not evidence the possible complex underpinnings of such knowledge; *inert* knowledge – which can be seen as 'stand alone' - which displays no interconnectedness with a wider context; *conceptually* difficult knowledge – that which, if not grasped, leaves students unable to move forward from their intuitive knowledge, and can result in mimicry of the subject and so a troubled or limited understanding can occur; *alien* knowledge – that which is counter-intuitive to what students already think they know, and *tacit* knowledge – that which operates unseen and is often the background knowledge that informs particular disciplines or subject areas.

Underpinning these characteristics is the notion of *liminality*. Meyer and Land argue that whilst students are trying to grasp a threshold concept, they can remain 'stuck' in a liminal space whilst they oscillate between previous and new understandings, thus experiencing a disjunction, particularly in relation to problem-based learning (Savin Baden 2000). Examples of such liminal or conceptual spaces include the period between adolescence and adulthood, and first-time motherhood: once entered there 'can be no ultimate full return to the pre-liminal state' (Meyer and Land 2005:376).

In Land *et al* (2005) the authors expand on the notion of a liminal space – a space where students find themselves outside their comfort zone – and how it is important that course design privileges this space (or holding zone) for students as they reconstitute their identities and learn to tolerate uncertainty. Further, the need for this safe space may be repeated as they progress.

It follows that developing methods to recognise when students are stuck in this liminal space will enable tutors to create strategies to help them become unstuck. This would ideally take into account variation in student knowledge on entry to the course, how they approach the threshold concept, what coping strategies they employ once they are within the liminal space, and how they move forward when emerging from it. However, the authors acknowledge a tension between the 'liquid' (fluid) liminal space and the need for structured outcomes demanded by an undergraduate degree (IBID:380).

The authors then suggest nine considerations for the design and evaluation of courses in higher education.

The first is the concept of 'jewels in the curriculum' and this relates to the transformative moments in a student learning journey. Using these 'jewels' as a central design point, the resulting curriculum can be shaped towards a framework of engagement to promote conceptual understandings, with the jewels acting as diagnostic points for tutors. Claiming that threshold concepts 'literally are the waypoints to be navigated…they are what really matters in the course and where

the key transformations educators wish to bring about take place.' the authors discuss how the liminal states that students enter are key points at which assessment practices can be used to assess how, and if, students have reached a point where they are able to inculcate a threshold concept. (Land and Meyer 2010:75).

This, the authors argue, is of utmost importance if curriculum assessment practices are to identify and deal with students who can 'produce the right answer, while retaining fundamental misconceptions' (IBID:62) and thus allows a moving away from the notion that students arrive at the 'finish line' at the same time. And so a 'one size fits all' assessment method will not capture the variations in student understanding (IBID:66) - with variation in this case relating to the 'extent or degree to which individuals vary and perform understanding.' (IBID:64)

Two examples are given for checking for variation, the first a declarative approach as developed by Kinchin and Hay (2000) – which, through concept mapping, allows both tutors and students to 'represent their current state of knowledge'. The second is 'talk aloud' protocols (Chi *et al* 1989), where 'a subject report[s] aloud what he or she is already saying privately while performing a task or solving a problem' (Hayes *et al* 1998:57).

Consequently, recognition of the variations pertaining to students when they are suspended in the liminal space can result in new and creative methods of assessment. This process will necessarily involve deviation and unexpected outcomes, so a course design that focuses on a prescribed outcome will preclude such a journey. Therefore, using the threshold concept framework can rattle 'the cage' of a linear approach to curriculum design that assumes standard and homogenised outcomes' (Land *et al* 2005:60).

Thus, the authors would seek assessment practices that fully utilise the threshold concept theory and so offer ways of assessing student conceptual formations in different stages of liminality (see page 18 for a further discussion of this four-stage approach). This should be underpinned with a clarification of variation within each

liminal state and also include a grading system that can cope with identified troublesome knowledge.

The second (of the nine considerations) relates to the nature of engagement and how important it is to offer specific, appropriate – perhaps provocative - forms that will assist students towards understanding the ways of thinking and practicing within a disciplinary community of practice. An example - taken from cultural studies - is the introduction of the idea that human beings do not have a 'soul', but instead are socially constructed. This can challenge common understandings and serve as an introduction to the cultural studies discipline, which focuses on exploring how meanings are generated within cultures.

A third is 'listening for understanding' to assess where in the learning journey the students are. This acknowledges a preliminal variation in that students will enter higher education from different starting points, with different knowledge and biographies, which will shape their subsequent understandings. As such, courses should allow spaces for tutors to detect not what the student knows, but how the student presents this knowledge.

The fourth point recognises that the grasping of a threshold concept may lead to an identity shift, typically through the inculcation of new thinking and new language: 'Threshold concepts lead not only to transformed thought but to a transfiguration of identity and adoption of an extended discourse' (Land *et al* 2005:53). This transformation can be linked to a 'letting go' of previously held conceptual stances and so can lead to 'disquietude and loss' (IBID:58),

The fifth suggestion outlines how, to help the students to cope with this 'letting go', there is a need to support students in self-regulating their anxiety when in a liminal state so they can safety tolerate and pass through it.

In other words, points four and five underline the need to support students through a period of liminality to allow them to both cope with and tolerate the resulting uncertainty.

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Point six discusses the problematic nature of simplistic course outcomes, with the authors arguing that by their troublesome nature, threshold concepts will demand a recursive approach where students tackle the concept from different angles until the wider connections are made. Linked to this is the idea of learning as an excursion – a journey that has an end-point in sight, but that contains a recursive aspect within it, and so the journey may involve points of departure and revised directions.

The seventh point **r**elates to the notion of preliminal variation mentioned earlier: that it is important when thinking about course design – particularly in enhancing retention and progression – to consider why 'some students productively negotiate the liminal space of understanding…and others find difficulty in doing so.' (Land *et al* 2005:60). Consequently, the authors argue that variation theory in terms of learning can help to expand students' exposure to a variety of ideas surrounding a particular phenomenon. According to Davies *et al* 'variation theory asserts that conceptual change depends on highlighting critical elements of a phenomenon by creating variation in these whilst all other elements are held constant'(2008:2). Land *et al* (2008:61) illustrate this by using an example of how a teacher presents the idea of a square to her students, contrasting angles of the square to the angles of a rhombus, and then discussing the presence of squares in everyday life such as on a chessboard, a dice or floor.

In point eight, the authors discuss the issue of 'good pedagogy' in that the practice of simplifying a threshold concept may simply lead to ritualised knowledge as students take the simplification at face value. In addition, relating threshold concepts to everyday knowledge/life experiences can be problematic, as this does not situate the threshold concept within the context of necessary discipline knowledge.

The ninth - and final - point addresses the need for students to understand the 'underlying game' - or episteme (Perkins (2006) - of the disciplinary community of practice. As such, the authorised understandings within a discipline may be

confusing for students as they may contrast with alternate, or common sense understandings. The example given outlines the differences in meaning of the words ‘depreciation’ and ‘profit’ within the economics discipline when compared to meanings in the outside world. The result can be that students may hold two distinct understandings of a threshold concept, one which is formed from ‘real life’ or common usage, and another that is presented to them within their course. If students do not recognise the difference and let go of the real life understanding and tutors do not realise that their teaching is operating at the tacit knowledge level, this can be a barrier to progression.

Therefore, the authors posit that mastery of disciplinary language for students leads to an important shift in terms of new thinking processes and that this language can be ‘natural’, ‘formal’ or ‘symbolic’ (Meyer and Land 2005:374). Thus, a student might master understanding of a certain disciplinary concept – in this case the example given is that of hegemony from within cultural studies – and the way in which this brings into view how students are culturally gendered. Another example given is how a learner of the French language will slowly acquire mastery of not just the language but the identity of a French speaker.

This inculcation of discipline language can be problematic, and using community of practice theory (Wenger 1998), the authors argue that disciplines can develop specific discourses that are poorly understood externally; equally, they can be poorly understood by those new to a discipline - but at the same time students are expected to converse and write within it. However, once mastered, the new discourses can lead to new thinking and thus enable a shift in the learner’s subjectivity and selfhood (Meyer and Land 2003:9).

Meanwhile, as mentioned on page 15, the authors went on to develop a four-stage model in 2008 that aims to capture the variation of a student’s understanding and journey towards and through the liminal space, with the threshold concept standing for the ‘constant’, whilst acknowledging the level of the underlying episteme (Meyer *et al* 2008).

The initial stage is a subliminal variation that relates to the learner's existing awareness of the rules of engagement within a discipline's community of practice, a way of knowing. Therefore, there will be variation in the entry point for students – some will be aware of the underlying game and some will not.

This initial stage is followed by a preliminal variation, and this relates to how the threshold concept comes into view. Again, there will be variation in the students' reaction to this, which will dictate whether they approach it with confidence or withdraw from it.

The third stage is a liminal variation – how the students cope with being suspended within the space – and how they negotiate, occupy and make sense of it; also how they pass, or not, through it.

The final stage is post-liminal variation: once the students emerge from the space, what is the conceptual space they now occupy? And how will they proceed from this point?

In conclusion, Meyer and Land posit that the threshold concept framework enables a focus on the 'learning episodes' that facilitate understanding of transformative concepts (Meyer *et al* 2008:71).

Threshold concepts as a research framework

Meyer and Land's theory of threshold concepts has usefully been discussed by Cousin in terms of its value as a research framework (2008, 2009).

For Cousin, the main difference between the threshold concept framework and other educational research methods lies in its ability to promote transactional curriculum inquiry, and its recognition that learning is a form of identity work.

Acknowledging that as a research method, the framework does 'not involve a specific method of enquiring with established techniques and procedures' (2009:201), Cousin also concurs with Meyer and Land's position that as an

analytical framework it can bring into view the ‘stuck’ places within the curriculum and thus aid the curriculum design process.

For Cousin, the theory’s usefulness centres around three particular research questions (IBID:206):

1 What do academics consider to be fundamental to a grasp of their subject?
2 What do students find difficult to grasp?
3 What curriculum design interventions can support mastery of these difficulties?

The first research question is felt to be important as instead of educational researchers imposing a research method on a discipline, the research begins with the academic, and as such, the academics are seen as the experts. Beginning in this way thus allows academics to discuss with the educational researchers - and if possible, with each other - what they think are the ‘stuck’ places for their students.

In addressing the second research question, a dialogue – informed by data gathered from the academics – then takes place between the educational researcher and the students.

Using the results of both dialogues, the researcher can help inform a curriculum design that inculcates a safe space, built around the liminal space of the ‘stuck’ points.

Therefore, the threshold concept research framework enables dialogue between all interested actors – the academic, the student and the educational researcher. It is this that distinguishes the threshold concept research framework from other educational research methods.

Having said this, Cousin does acknowledge that the theory draws upon other methods, for example, phenomenology. Phenomenological methods start from the point of view of the learner and attempts to identify variations in learning styles, something which the threshold concept framework also aims towards through the

use of the liminal phases outlined above. As such, phenomenological research methods can be characterised as student-centred, but, Cousin argues, this can cause problems for academics as it can lead to a 'symbolic shedding of the self as teacher' (2008:268). In this respect, Cousin states that some educational developers have been known to have little respect for 'sacred' academic territories. In addition, once the data gathering phase is over and the researcher has analysed the text detached from the learners, the result can lead to a researcher-led text detailing learners' experiences. In contrast, the threshold concept theory begins with a dialogue with the academics, and thus ensures that their expertise and knowledge of their subject is embedded in the research process.

Further, she also acknowledges that the concept of a liminal space is closely linked with, but is also different from, other ideas. In this respect, Cousin (2008:263) cites work from Maslow (1970) and Rogers and Freiberg (1993) – here the emphasis is on a safe space to allow progressive understanding, whereas the threshold concept framework provides a safe space for uncertainty: 'We need to convey to learners that discomfort and uncertainty are normal dimensions to learning' (IBID). Instead, the concept of a liminal space within the threshold concept framework is, she argues, more akin to Vgotsky's (1978) notion of the zone of proximal development (ZPD). However, she goes on to argue that the ZPD is a zone where learners can progress with the help of a skilled 'Other' and that it does not focus on the accompanying identity shift within the learner (IBID:265).

For a focus on identity, Cousin turns to Community of Practice, which as a social theory, contextualises learning as being part of a 'lived experience of participation in the world', rather than as an individual process (Wenger 1998:3). Wenger argues that learning takes place as part of a deepening process of participation in communities of practice and identities are thus formed. Important here is the notion of peripheral participation - the process of assimilating newcomers who are inducted in much the same way that existing members were inducted in their turn.

However, Wenger also points out that communities of practice are not havens of peace: relationships and practice are constantly evolving and the generational aspect of newcomers can cause conflict as they introduce new ideas and

perspectives. So, the influx of the ‘new’ is what ‘propels the practice forward.’(IBID 101; Osmond 2012). Thus, Cousin links the conflict which takes place between existing members and newcomers within a community of practice with how threshold concept theory enables a space for a community of academics and students researching together.

Thus the notion of transactional curriculum inquiry comes into focus in that the threshold concept research framework enables and encourages dialogue between each individual actor – the subject specialist, the educational research specialist, the student and the curriculum designer. This enables all to not only exchange views, but also to research, discuss, negotiate and scaffold any identified ‘stuck places’. In essence then, none of the actors are imposing a view or mode of thought on each other – rather, much as a threshold concept operates, the information simultaneously clicks together to inform curriculum design.

4 Synopses of the submissions

Submission [1]

Osmond, J., Turner, A., and Land, R. (2008) 'Threshold Concepts and Spatial Awareness in Automotive Design'. in *Threshold Concepts within the Disciplines*. ed. by Land, R., Meyer, J., and Smith, J. Rotterdam: Sense Publishers, 243-258

This invited book chapter is the result of a paper presented at the inaugural international 'Threshold Concepts within the Disciplines Symposium' in Glasgow (2006). The paper was subsequently chosen for a peer-reviewed book chapter in *Threshold Concepts within the Disciplines* (Sense Publishers, 2008). Edited by the theory founders, this is the first book in a series that contains a selection of papers exploring the use of the threshold concept theory within different disciplines.

The chapter represents the first published account of using the theory to explore industrial design. Previously, the theory had been applied to disciplines such as maths, economics and history, and so the chapter represents an original and significant publication in relation to pedagogic research within the industrial design discipline.

A key contribution of this paper is a recognition of:

- The lack of readily identifiable boundaries within creative arts subjects
- A previously unarticulated and tacit episteme within the industrial design discipline
- The usefulness of the threshold concept theory when applied to pedagogic design research

This publication addresses the following objectives of this body of work:

1	Explore the educational experience of undergraduate level industrial design students through a longitudinal study

Authorship: Written as first author, my contribution represents 60% of the work.

Submission [2]

Osmond, J. and Turner, A. (2008) 'Measuring the creative baseline in transport design education'. in *Improving Student Learning – For What?.* ed. by Rust, C. Oxford: OCSLD, 87-101

This peer-reviewed paper was presented at the international *Improving Student Learning* conference in 2007 and represents the second published account of applying the threshold concept theory within industrial design.

The paper focuses in more detail on how the first year of research was unable to establish a common understanding with both staff and students in relation to spatial awareness, which was presented by staff as a possible threshold concept. This lack of common understanding was also identified in the literature in which several phrases and definitions are offered (see Bodner and Guay, 1997; Eliot, 2002; Gardner, 1983; Garg *et al*. 1999; Karnath *et al*. 2001; Shearer, 2004).

However, the dialogue with staff did enable the identification of several possible threshold concepts, and after the implementation of a specifically developed spatial awareness pilot test (alongside an existing spatial awareness test[7]) showed no correlation between first year student scores and end-of-year assessment results, the research focus was revised. This revision led towards the investigation of the 'confidence to challenge design conventions' as a potential threshold concept. Defined by staff as 'inculcating design conventions and expanding upon them using information from a variety of sources and experiences', it was seen as akin to Perkins' idea of breakthrough thinking (2000).

A key contribution of this paper is:

- A confirmation that the notion of spatial awareness was unlikely to be a threshold concept in itself
- A recognition that the 'confidence to challenge design conventions' merited further research in terms of threshold concepts

This publication addresses the following objectives of this body of work:

[7] The Purdue Visualization of Rotations Test (Bodner and Guay1997)

1:	Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2:	Identify one or more key threshold concepts in industrial design

Authorship: Written as first author, my contribution represents 70% of the work.

Submission [3]

Osmond, J. (2009) 'Stuck in the bubble: Identifying Threshold Concepts in Design'. *Dialogues in Art and Design: Promoting and Sharing Excellence.* GLAD Conference Proceedings*.* held on 21-22 October at York St John University, 131-135

This peer-reviewed paper was presented at the *Group for Learning in Art and Design (GLAD)* conference in 2009*,* and represents the first publication outside the threshold concept field about the pedagogic research undertaken by CEPAD.

Specifically, the paper details how further investigation, through a second staff meeting and one-to-one interviews with students, identified the threshold concept as being the process leading up to the 'confidence to challenge design conventions'. Labelled as the 'toleration of design uncertainty', the threshold concept was defined as:

> …the moment when a student recognises that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process.

Using Meyer and Land's characteristics of a threshold concept, the paper details how the toleration of design uncertainty can be seen as *transformative* in that the acceptance of uncertainty is a prerequisite for the process of design, and thus student designers begin their journey towards a designer identity. It is *irreversible* in that the students would find it very difficult to 'un-think' themselves from a design identity, and *integrative* in that they realise that everything they know, learn and experience is a legitimate source of inspiration (for example, accepting that those moments when they are thinking about subjects that are not directly related to their task may turn out to be the most important part of the process). Most of all, it is *troublesome* in that the students will constantly experience and re-experience 'surfacing around', or uncertainty, as they hunt for a solution, even when they attain the status of professional designer.

The paper also outlines how the identification of the threshold concept was informed by data gathered from both staff and student data and underpinned by the design and creativity literature. It also touches on how the data indicated that

students' ability to pass through this threshold may be linked to their previous creative educational background.

Feedback from academics at the GLAD conference unearthed how difficult it can be for academics in Art and Design disciplines – often populated by tutors who are practitioners first and teachers second - to frame and publish research in the creative arts, which led to a paper presented at the Design and Research Society conference in 2011 (see submission 7).

A key contribution of this paper is:

- The identification of the 'toleration of design uncertainty' as a threshold concept associated with conceptualising solutions
- Confirmation of how the threshold concept framework enables a transactional curriculum inquiry with the identification of the threshold concept being the result of a triangulation of data from staff, students, and relevant literature.

This publication addresses the following objectives of this body of work:

1:	Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2:	Identify one or more key threshold concepts in industrial design

Authorship: Sole author

Submission [4]

Osmond, J. and Turner, A. (2010) 'The Threshold Concept Journey: from identification to application'. in *Threshold Concepts and Transformational Learning.* ed. by Meyer, J., Land, R. and Baillie, C. Rotterdam: Sense Publishers, 347-363

This invited book chapter was originally presented as a peer-reviewed paper at the international biennial threshold concept conference: *Threshold Concepts Conference: from theory to practice* at Queens University, Ontario (2008).

This book, edited by the theory founders, is the second in a planned series that contains papers exploring the use of the threshold concept theory within different disciplines, with the focus on application of the theory. The chapter, which solidifies the identification of the toleration of design uncertainty, represents a continuum of the progress into exploring threshold concept theory in relation to industrial design. This it represents a significant, solid, baseline for the design teaching community to take forward thinking in the field.

A key contribution of this chapter is:

- The triangulation of the qualitative data with the design literature - in particular to Wallace's concept of a 'bubble' which has resonance with Meyer and Land's liminal space, within which student designers need to negotiate their uncertainty during the design process
- A consideration of other possible threshold concepts in subsequent years of the course
- The implications for teaching and learning practices for the first year of study
- The preliminary development of a model that incorporates the threshold concept within the industrial design programme of study

This publication addresses the following objectives of this body of work:

1:	Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2:	Identify one or more key threshold concepts in industrial design
3:	Relate the threshold concept theory to relevant aspects of design education

Authorship: Written as first author, my contribution represents 80% of the work.

Submission [5]

Osmond, J., Bull, K., Tovey, M. (2009) 'Threshold concepts and the transport and product design curriculum'. *Art, Design and Communication in Higher Education*. 8, 2, December, 169-175(7)

This journal article was commissioned for a special edition of *Art, Design and Communication in Higher Education*, which was devoted to the outputs of the UK CETLs.

A key contribution of this journal article is:

- A discussion about supportive frameworks within the curriculum to legitimise student experience of uncertainty when approaching design problems
- Further thinking around a model that inculcates the toleration of design uncertainty within the pre-concept design stage

This publication addresses the following objectives of this body of work:

1:	Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2:	Identify one or more key threshold concepts in industrial design
4:	Relate the threshold concept theory to design theory
5:	Relate the emerging constructs to novel design pedagogy arrangements

Authorship: Written as first author, my contribution represents 70% of the work.

Submission [6]

Tovey, M., Bull, K., Osmond, J. (2010) 'Developing a Pedagogic Framework for Product and Automotive Design'. *Design Research Society Design & Complexity Conference*. held July 7-9 at Université de Montréal

This peer-reviewed paper was presented at the Design Research Society's *International Design & Complexity Conference* in 2010 and was subsequently published in the conference proceedings.

The paper represents one of the first presented as part of the DRS SIG on Design Pedagogy which was set up as a specific outcome of the CEPAD project. The paper details how the threshold concept pedagogic research resulted in a redesigned course programme, which now privileges a safe creative space within which students can experiment and experience intense uncertainty within a supportive environment. This signified a key change for the curriculum.

A key contribution of this paper is:

- A consideration of the design process in terms of an analysis/synthesis model, linked to a designerly way of knowing and design solutioning
- Further development of a model, inculcating threshold concepts to inform curriculum development
- The development of a new curriculum model

This publication addresses the following objectives of this body of work:

1:	Explore the educational experience of undergraduate level industrial design students through a longitudinal study
2:	Identify one or more key threshold concepts in industrial design
3:	Relate the threshold concept theory to relevant aspects of design education
4:	Relate the threshold concept theory to design theory
5:	Relate the emerging constructs to novel design pedagogy arrangements
6:	Signal directions for further pedagogic research

Authorship: My contribution represents 50% of the work.

Submission [7]

Osmond, J. (2011) 'A 'Wicked' problem for a 'Wicked' Discipline'. *Researching Design Education: 1st International Symposium for Design Education Researchers.* CUMULUS // DRS 2011. held on 18-19 May in Paris, 141-155

This peer-reviewed paper, subsequently published in the conference proceedings of the international DRS/Cumulus conference in 2011, is a position piece about how using threshold concepts to investigate the industrial design discipline adds to the growing body of pedagogic research in the creative arts field.

The paper extrapolates the experience of researching the ways of thinking and practicing in a UK industrial design course into the wider context of UK government announcements that the HE teaching budget would no longer exist from 2012 for Humanities subjects, within which creative disciplines sit. The paper argues that the decision by the UK government to cut the teaching budget for Humanities subjects could be a direct consequence of a lack of published educational research within creative disciplines, due to creative arts subjects historically being vocational in nature and typically delivered by practitioners, rather than academics.

A key contribution of this paper is:

- The identification of the need to encourage robust pedagogic research in the creative arts in order to defend and maintain creative courses and so produce industry-ready graduates who can productively contribute to the economy
- How the threshold concept framework can aid such pedagogic research as it enables an exploration of an often 'wicked' discipline area which contains 'wicked' problems (Buchanan 1992) and so is not easily measureable against government metrics

This publication addresses the following objectives of this body of work:

3:	Relate the threshold concept theory to relevant aspects of design education
5:	Relate the emerging constructs to novel design pedagogy arrangements
6:	Signal directions for further pedagogic research

Authorship: Sole Author

Submission [8]

Osmond, J. (2012) 'Passports to a community of practice' in *Design for Transport*. ed. by Tovey, M. UK: Gower, 335-352

This peer-reviewed book chapter examines how both community of practice theory and the threshold concept framework can illuminate the ways in which student car designers build and develop their professional design identities, working towards a passport to their community. Focusing on student use of the industry-recognised *Car Design News* webzine as an example of how students judge themselves against their professional design community, the chapter discusses another potential threshold concept, this time relating to work-based placements and the development of an online portfolio of work.

A key contribution of this chapter is:

- The linking of community of practice theory and threshold concept theory
- The possible identification of a new threshold concept, this time related to interactions with professional communities of practice

This publication addresses the following objectives of this body of work:

2:	Identify one or more key threshold concepts in industrial design
6:	Signal directions for further pedagogic research

Authorship: Sole Author

Submission [9]

Osmond, J. (2013) 'The scholarship of teaching: threshold concepts and research informed design education'. *DRS//CUMULUS Oslo 2013 Proceedings*. Oslo. 14-17 May. Volume 2: ISBN 978-82-93298-02-1

This peer-reviewed paper, presented and subsequently published in the international Design Research Society/Cumulus 2013 conference proceedings, considers how the outcomes of the CEPAD research into threshold concepts in design impacted on the continuing professional development of staff and their teaching and learning practices. As such, the paper can be seen as the latest significant and original contribution to the research culture within the international field of design, underpinned by the DRS SIG on Design Pedagogy, which is seen as an important component of the biennial DRS/Cumulus and DRS conferences.

A key contribution of this chapter is:

- The linking of the use of the threshold concept theory with continuing professional development and publishing profiles
- The linking of the use of the threshold concept theory with thinking processes in terms of curriculum development

This publication addresses the following objectives of this body of work:

3:	Relate the threshold concept theory to relevant aspects of design education
5:	Relate the emerging constructs to novel design pedagogy arrangements

Authorship: Sole Author

Submission [10]

Bull, K. and Osmond, J. (2013) 'Design Education and non-EU students: shifts in teaching practice'. *DRS//CUMULUS Oslo 2013 Proceedings*. Oslo. 14-17 May. Volume 1: ISBN 978-82-93298-01-4

This peer-reviewed paper, presented and subsequently published in the international Design Research Society/Cumulus 2013 conference proceedings, discusses how the outcomes of the CEPAD research into threshold concepts in design influenced the teaching and learning practices within a particular MA course.

In particular, the paper considers a case study relating to international MA students and how a design teaching team, using the threshold concept identified for Year 1 students – the toleration of design uncertainty – shifted from a sequential method of teaching, towards a more conceptual mode. This shift was underpinned by the use of visual tools and a greater emphasis on group collaboration, and these innovations are now embedded within the course curriculum. Early indications are that students are much more engaged and confident in the embracing of research territories, and the innovations have also been introduced across the wider MA curriculum.

A key contribution of this paper is:

- The identification of the usefulness of the year 1 threshold concept theory in relation to international MA students
- Evidence of the impact of the threshold concept theory on the staff complement

This publication addresses the following objectives of this body of work:

6:	Signal directions for further pedagogic research

Authorship: Second author, my contribution represents 40% of the work

Other relevant publications:

Bull, K., Osmond, J., Barratt, A., (2013) 'Wheel of Design – reflective alignment of design skills with aspirations'. *The International Conference on Engineering and Product Design Education*. held 5-6 September at Dublin Institute of Technology.

Johnson, C., Bull, K., Osmond, J. (2013) 'Co-operative Design and Communities of Practice'. *The 10th International Conference on Cooperative Design, Visualization and Engineering*. held 22-25th September at Mallorca, Spain.

Osmond J. and Mackie, E. (2012) 'Designing for the 'Other''. *DRS 2012.* held 1-4 July at Chulalongkorn University, Bangkok.

Osmond, J. and Clough, B. (2012) 'Involving Assessment Buddies in the Assessment of Design Project Work'. *Design and Technology Education: An International Journal.* Vol 17, 2, 62-67

5 Critical Reflection

The submissions

In reviewing the research that underpins the submissions in this body of work, three clear benefits emerged from using the threshold concept framework to investigate the industrial design course.

The first is that the threshold concept framework proved most useful in unearthing the underlying episteme of the industrial design discipline. Using the threshold concept framework showed that, despite a common consensus of the tutors that the development of spatial awareness was a crucial aspect of the course for students and therefore was a threshold concept, the threshold concept was, in fact, the toleration of design uncertainty.

This finding points to how a common consensus can become fact within a discipline, but when examined, turns out to be erroneous. Having said this, the difficulty in understanding the notion of threshold concepts has a part to play in this as, although not a threshold concept in itself, spatial awareness development *is* a crucial component of the course. However, it can be considered a core building block, rather than a threshold concept. This misunderstanding may well have resulted in the research focus into spatial awareness development being written into the original CETL bid, and subsequently led to a two-year period of research around this.

The second benefit is that although it took two years of research to identify the threshold concept, the process was nonetheless useful in that it facilitated a space for open dialogue between staff, students and researchers. This dialogue fostered a spirit of transactional curriculum inquiry with members of staff that is still evidenced today within CEPAD, with several members of staff now viewing their teaching and learning practices through a threshold concept lens. This in turn has led to a series of research projects into modules, subsequent revisions of those modules and writing the results up for publication, thus enhancing staff publishing profiles.

The third benefit is using the theory allowed the identification of one of the 'jewels in the curriculum' – and the need to scaffold and support students through the associated liminal space whilst they struggle with the uncertainty they feel when first faced with a course that privileges creativity and innovation. The data suggests that for first year students and post-grad international students in particular, the culture shock of entering such a course from a previously much more prescribed 'what do I need to do to pass' educational culture, creates a real anxiety and this can set up a barrier to creativity.

Thus, supporting students through such a creative liminal space can help them manage their anxiety and use it to fuel their creative thinking. Early indications from data gathered from the 2010 first and second year students, after the curriculum redesign, were that they were evidencing lower levels of anxiety than previous cohorts.

However, as the funded CETL contract was completed in 2010, I was redeployed elsewhere for one year. Consequently it was not possible to carry out further research in this area at that time. In addition, when I returned to CEPAD, the curriculum had undergone a further redesign, so the chance for detailed comparison was lost.

Similarly, there were further possible threshold concepts identified - for example, empathy (used to frame Osmond and Mackie 2012), group work and co-operative learning (used to frame Johnson *et al* 2013) and research methods with international students (used to frame Bull *et al* 2013) - which could not be explored in more depth because of the ending of the CETL funding. Having said this, three members of staff have used the threshold concept theory to frame their understanding of their modules and publish subsequent conference papers.

Another aspect of the threshold concept theory that was not fully explored was that of variation. As discussed previously, Meyer and Land propose that four stages – sub, pre, liminal and post-liminal - variation be used to assess student understandings on entry to the course, when approaching a threshold concept, when in the liminal space and post-emergence. There are indications that this

variation does exist in relation to the toleration of design uncertainty in that the original cohort of students interviewed displayed differing levels of anxiety in relation to their creative confidence - with some breaking through and others leaving the course. A recommended area for further research would be to develop a method to gauge student variation in understanding before entry to the course – and perhaps at the beginning of each study year for identified threshold concepts. This would allow a revision of the curriculum around the crucial liminal spaces in order to support students through this process.

In summary, the threshold concept theory was of use within industrial design as it allowed an open dialogue with staff, students and researchers which resulted in a redesign of the curriculum to support students through their creative anxiety, and enhanced both staff research profiles and a research culture within the department. On an external basis the publications that resulted from the research contributed new knowledge to both the threshold concept and design pedagogy fields.

Research journey

Upon taking up the Senior Research Assistant post for CEPAD in 2005, I was a relatively new researcher. After obtaining a first class honours degree in Communication, Culture and Media in the Coventry School of Art and Design in 2001, I was subsequently employed as a Research Assistant on a variety of projects. Although I had undertook some research within the Industrial Design Department for the Dean of the School, I had not, up until this point, been directly involved with the industrial design course.

The result of this was that although I had the requisite research skills to undertake the work, I was not familiar with the industrial design discipline. However, rather than this being a drawback, it aided the research process as I brought a fresh eye to the table.

An example of this was during an observation period of the student recruitment process where I found the concentration on students' spatial awareness skills in portfolios presented at interview, difficult to understand. Often, a successful

student would be chosen on the basis of a sketch within the portfolio, which the recruiting tutors contended was evidence of spatial awareness skills. This was my first introduction to the notion of spatial awareness within industrial design, and stood me in good stead when involved in the first staff meeting in 2006. At this meeting there was a great deal of discussion about what spatial awareness meant as a concept, and I could see that different tutors had different interpretations. This was also reflected by the students in that they demonstrated varying understandings of the concept - from little to none in most cases.

As a researcher, this meant that trying to achieve one of the CEPAD aims of developing a test to measure spatial awareness development in students was somewhat problematic, although I did design a pilot test in conjunction with selected members of industrial design staff.

The conclusion reached was that spatial awareness development in students was possibly not a threshold concept in itself and this was borne out by the results of the spatial awareness pilot test. Because I had a fresh eye, this was a relatively unproblematic realisation as I was not wedded to the idea that spatial awareness development was the crucial transformative aspect of student development within the course. This meant that the focus could shift towards exploring further the other potential threshold concepts that emerged from both staff and student data.

Another area of unfamiliarity was the notion of threshold concepts – hitherto, I had not come across this theory and so approached the theory from a research stance of troubled understanding. Because of this, when this struggle was reflected in both the staff feedback, and externally - for example in conference feedback when presenting to design tutors - I was able to articulate the theory based on my own struggle. Most helpful in this struggle was my realisation that I had experienced mastery of particular threshold concepts during my recent degree course (1998-2001) and so had close experience of the transformative shift - complete with personal resistance - that the threshold concept theory typifies.

As outlined above, the journey to identifying threshold concepts can be characterised by a positive struggle for understanding. However, this struggle was

compounded by the Research Fellow, Professor Ray Land, leaving the University just before the research commenced, and I was then required to develop the research framework, as outlined in the original bid, from scratch. I am very grateful to both Professor Land for his advice after he left, and Dr Andrew Turner who was seconded to CEPAD on a 15% contract. Nevertheless, by the third year of the project, I was solely responsible for developing and implementing the research strategy, amid a further difficulty of three changes of management. Consequently, I am also indebted to both Professor Mike Tovey and Dr Karen Bull for their advice and input during their management of the project.

In addition, as outlined previously, CEPAD was re-organised following the ending of CETL funding in 2010 and I was redeployed to a post in Health and Life Sciences. The year away from the department interrupted my research and I was unable to complete a detailed comparison of the similarities and differences between the old course structure and the new, as by the time I returned, the course design had undergone a further change, so such a comparison was not possible.

Despite these difficulties, my journey as a researcher during the longitudinal study with CEPAD, taught me that struggle and subsequent reflection is a necessary component of understanding, and this has helped me to nurture both the struggle and the understanding of selected members of staff within the industrial design department who have now inculcated the theory and are using it to explore their teaching practices, frame research and write it up for publication.

6 Conclusion

The portfolio of work presented within this submission is comprised of a series of publications which outline qualitative research into threshold concepts in industrial design undertaken by CEPAD between 2005-2010.

The background to the research is outlined, specifically the main points pertaining to the threshold concept theory developed by Meyer and Land in 2003. In essence, the theory relates to the notion of transformative conceptual gateways, or 'jewels in the curriculum', which students need to grasp before they can move on successfully with their studies. Underpinning these conceptual gateways are liminal spaces, within which students can struggle for understanding and become 'stuck', unable to progress. Meyer and Land argue that identifying and recognising these conceptual gateways and their associated liminal spaces, and then assessing variations of understanding both outside and within them, can inform curriculum design. This assessment of variation can also surface understandings of the hidden episteme – or ways of thinking and practising - contained within a subject. They further argue that the importance of using the threshold concept framework relates to the recognition that students will experience identity shifts as they progress through conceptual gateways, and thus become qualified to enter their professional community of practice, not only in terms of professional skills, but also in terms of assuming professional identities.

Also outlined is a consideration of the usefulness of using the threshold concept framework as a research method, with the main advantage, and difference from other research methods, relating to the notion of transactional curriculum inquiry. In summary, using the framework involves all actors – staff, students, researchers and curriculum designers – and so the results of any research takes into account all involved, whilst still privileging tutors as the subject experts.

This submission then outlines how the overall aim of the research - to determine the threshold concept framework role and contribution to undergraduate level industrial design education – was achieved by mapping each individual submission against a series of specifically devised objectives, which give shape to the programme of work.

In essence, the attached publications detail how both staff and students were interviewed during 2005-2010 in order to identify what, if any, threshold concepts were present within the industrial design course. Using Meyer and Land's characteristics of a threshold concept, a specific conceptual gateway, or 'jewel in the curriculum', was identified: 'the toleration of design uncertainty' which related to first year undergraduate teaching and learning. As a result, the undergraduate curriculum was re-designed to provide safe spaces within which students could develop their creative confidence. In addition, the threshold concept was found to have resonance with a cohort of international MA students. Another potential threshold concept, linked to professional development, was also tentatively identified. The impact of the theory was then examined in relation to individual staff development and their teaching and learning practices. There is also a consideration of how the identification of the threshold concept moved forward knowledge within both the existing threshold concept literature and built upon the work of notable design theorists.

Several of the themes highlighted by Meyer and Land's work emerged during the research, firstly that of hidden epistemes – ways of thinking and practising within disciplines. As submission one outlines, the starting point given by staff was that spatial awareness development was a threshold concept, and this was agreed by the whole staff complement. However, this proved not to be the case - highlighting that the underlying agendas, or epistemes, of disciplines are often tacit and unarticulated - as outlined in submission two. Instead, the notion of creative uncertainty emerged from the staff and student data and resulted in the identification of the threshold concept, outlined in submission three. This process also highlighted another theme, in submission four - that of Cousin's transactional curriculum inquiry. Through the data gathering process and analysis of this data, it was apparent that the identified threshold concept was arrived at as a direct result of staff and student feedback, which was then framed by the theory and the design literature by myself as researcher and presented to staff for validation. As outlined in submission five, from this the idea of supportive frameworks and a proposed model of a new curriculum was developed, chiming with Meyer and Land's work on building the curriculum around conceptual gateways. This was expanded upon

further in submission six, which details how the curriculum was completely redesigned in 2010.

However, the threshold concept work has also proved useful on an on-going basis, firstly as outlined in submission seven as a basis for thinking about the need for a robust research culture within the creative arts, in particular in response to UK government reduction of course funding for the Humanities. Secondly, as detailed in submission eight, there emerged another potential threshold concept relating to student professional identities as designers, concurring with Meyer and Land's assertion that grasping threshold concepts will also incur an identity shift in students. Moving towards a staff focus, submission nine considers the impact of exposure to the threshold concept framework on staff and how, for several members, it has not only enabled them to innovate their teaching and learning practices, but also has enhanced their continuing professional development in terms of publishing. Staying with a staff focus, an example of innovation is offered in submission ten, where a design teaching team changed their curriculum delivery after realising that the threshold concept identified for first year students was also applicable to international MA students.

Externally, the work has had a wider impact, both by furthering the threshold concept theory within the educational pedagogy field and also the widening and adding to the use of theory in relation to pedagogy within the Art and Design Discipline. The latter is evidenced by the setting up of the DRS SIG on Pedagogy, which has now become an important element for the international biennial DRS Cumulus and DRS conferences.

Limitations of the research, due to redeployment, include aspects of the threshold concept theory which were not fully explored, such as variation in understanding with students, the development of understanding around other potential threshold concepts, and a detailed analysis of the differences in student confidence between the old course structure and the new.

Despite this, the submissions do outline how the identification of a threshold concept was arrived at, using Meyer and Land's theory, and thus we can conclude

that there is at least one key threshold concept which plays a key role within undergraduate level industrial design – the toleration of design uncertainty - which underpins the confidence to challenge design conventions and thus conceptualise new solutions. Areas for further research have also been identified, particularly in relation to the measurement of variation in student understanding and the development of other potential threshold concepts.

Meanwhile, two further papers have been submitted – one a sole authored chapter in a forthcoming *Design Pedagogy* book to be published by Gower. Entitled *Industrial Design and Liminal Spaces*, this chapter explores the toleration of design uncertainty and its concomitant emphasis on the concept of liminal spaces to that of the professional design process through using lenses developed by Daly *et al* (2012). In addition, a conference paper has been submitted to the Engineering and Product Design Education 2014 conference. Entitled *Design Pedagogy and the Threshold of Uncertainty*, this considers how threshold concepts/liminal spaces can move the emphasis away from the content of the curriculum towards the importance of practical, embodied, and experiential ways of knowing.

In summary, the overall intention of the body of work has been achieved.

7 References

Baillie, C. (2003) *The Travelling CASE: How to foster creative thinking in Higher Education.* UK: LTSN

Bodner, M. and Guay, R. (1997) 'The Purdue Visualization of Rotations Test'. *The Chemical Educator* 2, 1 - 17

Buchanan, R. (1992) 'Wicked Problems in Design Thinking'. *Design Issues*. 8, 2, Spring. USA: MIT Press, 5-21

Bull, K. and Osmond, J. (2013) 'Design Education and non-EU students: shifts in teaching practice'. *DRS//CUMULUS Oslo 2013 Proceedings*. Oslo. 14-17 May. Volume 1: ISBN 978-82-93298-01-4

Bull, K., Osmond, J., Barratt, A. (2013) 'Wheel of Design – reflective alignment of design skills with aspirations'. *The International Conference on Engineering and Product Design Education*. held 5-6 September at Dublin Institute of Technology.

Chi *et al* 1989, 1994 quoted in Meyer, J., and Land, R. (2010) 'Threshold Concepts and Troublesome Knowledge'. in *Threshold Concepts and Transformational Learning*. ed. by Land, R., Meyer, J., and Baillie, C. Rotterdam: Sense Publishers, 65

Clouder, L. (2005) 'Caring as a 'threshold concept. Transforming students in higher education into health (care) professionals'. *Teaching in Higher Education* 10, 505-517

Cousin, G. (2006) 'Threshold concepts, troublesome knowledge and emotional capital: an exploration into learning about others'. in *Overcoming Barriers to Student Understanding. Threshold concepts and troublesome knowledge.* ed. by Meyer, J., Land, R. London and New York*:* Routledge, 134-147

Cousin, G. (2006a) ‘An introduction to threshold concepts’. (online) *Planet*. No. 17. December. Available from neillthew.typepad.com/files/threshold-concepts-1.pdf. [26th July 2013]

Cousin G. (2008) ‘Threshold Concepts, old wine in new bottles or new forms of transactional curriculum inquiry?’ in *Threshold Concepts within the Disciplines.* ed. by Land, R., Meyer, J. and Smith, J. Rotterdam: Sense Publishers, 261-272

Cousin, G. (2009) ‘Transactional Curriculum Inquiry’. *Researching Learning in Higher Education*. Abingdon & NY: Routledge, 201-212

Coventry University (2010) *CETL Final Self Evaluation Report March 2010:* available on request from Professor Mike Tovey.

Cowart, M. (2010) ‘A Preliminary Framework for Isolating and Teaching Threshold Concepts in Philosophy.’ in *Threshold Concepts within the Disciplines*. ed. by Land, R., Meyer, J. and Smith, J. Rotterdam: Sense Publishers, 131-145.

Cross, N. (1992) ‘Research in Design Thinking’. in *Research in Design Thinking*. ed. by Cross, N., Dorst, K., Roozenburg, N. Netherlands: Delft University Press, 3-10

Daly, S., Adams, R., Bodner, G. (2012) ‘What Does it Mean to Design? A Qualitative Investigation of Design Professionals’ Experience’. *Journal of Engineering Education*. April, 101, 2, 187-219. ASEE

Davies, P., Lundholm, C., and Mangan, J. (2008) ‘The application of variation theory in undergraduate teaching: addressing some difficulties in the context of students’ understanding of saving.’ *3rd international conference of the Phenomenography and Variation Theory Special Interest Group*. *European Association for Research on Learning and Instruction conference.* held in Kristianstad, Sweden.

DeBono, E. (1995) 'Exploring patterns of thought: Serious Creativity'. *Journal for Quality and Participation* 18 (5), 12-18

Dorst, K. (2003) *Understanding Design 150 Reflections on Being a Designer*. Amsterdam: BIS

Eliot, J. (2002) 'About spatial intelligence: I.' *Perceptual and Motor Skills* 94, 2, 479-186.

Gardner, H. (1983) *Frames of Mind: the theory of multiple intelligences*. New York: Basic Books

Garg, A., Norman, G., Spero, L. and Taylor, L. (1999) 'Learning anatomy: do new computer models improve spatial understanding?' *Medical Teacher*. 21, 519-522

Hall, B. (2011) 'Threshold Concepts and Troublesome Knowledge: Towards a 'Pedagogy of Climate Change'?' (online) Available from: The Gees Subject Centre http://gees.ac.uk/pubs/other/pocc/pocc.htm [26 June 2013]

Hayes, S., White, D., Bissett, T. (1998) Protocol Analysis and the "Silent Dog" method of analyzing the impact of self-generated rules. *The Analysis of Verbal Behavior*, 15 57-63

HEFCE (2011) 'Summative evaluation of the CETL programme'. *Final report by SQW to HEFCE and DEL December*. Available online: https://www.hefce.ac.uk/media/hefce/content/pubs/indirreports/2011/re1111evalofcetl/rd11_11.pdf [26 January 2014)

HEFCE (2013) 'Centres for Excellence in Teaching and Learning'. (online) Available from: http://www.hefce.ac.uk/whatwedo/lt/enh/cetl/ [20th September 2013)

Johnson, C., Bull, K., Osmond, J. (2013) 'Co-operative Design and Communities of Practice'. *The 10th International Conference on Cooperative Design, Visualization and Engineering*. held 22-25th September at Mallorca, Spain.

Karnath, H., Ferber, S., and Himmelbach, M. (2001) 'Spatial awareness is a function of the temporal not the posterior parietal lobe.' *Nature*, 411 (6840), 950-3

Kinchin and Hay (2000) quoted in Meyer, J., and Land, R. (2010) 'Threshold Concepts and Troublesome Knowledge'. in *Threshold Concepts and Transformational Learning.* ed. by Land, R., Meyer, J., and Baillie, C. Rotterdam: Sense Publishers, 64

Kleiman, P. (2008) 'Towards transformation: conceptions of creativity in higher education' *Innovations in Education and Teaching International* Vol. 45, No. 3, 209–217

Land, R., and Meyer, J. (2008) (eds) *Threshold Concepts within the Disciplines*. Rotterdam: Sense Publishers

Land, R., and Meyer, J. (2010) 'Threshold concepts and troublesome knowledge (5): Dynamics of Assessment'. in *Threshold Concepts within the Disciplines*. ed. by Land, R., Meyer, J. and Smith, J. Rotterdam: Sense Publishers, 61-79

Land, R., Cousin, G., Meyer, J. and Davies, P. (2005) 'Threshold concepts and troublesome knowledge (3): implications for course design and evaluation'. (online) C. Rust, ed. Improving Student Learning - diversity and inclusivity, Proceedings of the 12th Improving Student Learning Conference. held 2004 in Birmingham. 53-64. Available from: http://www.brookes.ac.uk/services/ocsld/isl/isl2004/abstracts/conceptual_papers/ISL04-pp53-64-Land-et-al.pdf [19th June 2013]

Lucas, U. & Mladenovic, R. (2006) 'Dissolving the boundary between research and teaching: exploring threshold concepts within introductory accounting'. *SRHE*:

Beyond Boundaries, New Horizons for Research into Higher Education. held 12-14 December, Brighton, UK.

Meyer, J., and Land, R. (2003) ‘Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines’. Occasional Paper 4 (online). Available from: http://www.etl.tla.ed.ac.uk/docs/ETLreport4.pdf. [26th September 2013]

Meyer, J., and Land, R. (2005) 'Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning'. *Higher Education* 49, 373–388

Meyer, J. and Land, R. (2006) *Overcoming Barriers to Student Understanding. Threshold concepts and troublesome knowledge*. ed. by Meyer, J., Land, R. London and New York: Routledge.

Meyer, J., Land, R., and Davies, P. (2008) ‘Threshold concepts and troublesome knowledge (4): Issues of variation and variability’. in *Threshold Concepts within the Disciplines.* ed. by Land, R., Meyer, J. and Smith, J. Rotterdam: Sense Publishers, 59-74

Orsini-Jones, M. quoted in Cousin, G. (2009) *Researching Learning in Higher Education*. London and New York: Routledge, 209

Osmond, J. (2009) 'Stuck in the bubble: Identifying Threshold Concepts in Design'. *Dialogues in Art and Design: Promoting and Sharing Excellence.* GLAD Conference Proceedings. held on 21-22 October at York St John University, 131-135

Osmond, J. (2011) 'A ‘Wicked’ problem for a 'Wicked’ Discipline'. *Researching Design Education: 1st International Symposium for Design Education Researchers.* CUMULUS // DRS 2011. held on 18-19 May in Paris, 141-155

Osmond, J. (2012) ‘Passports to a community of practice’. in *Design for Transport*. ed. by Tovey, M. UK: Gower, 335-352

Osmond, J. (2013) ‘The scholarship of teaching: threshold concepts and research informed design education’. *DRS//CUMULUS Oslo 2013 Proceedings*. Oslo. 14-17 May. Volume 2: ISBN 978-82-93298-02-1

Osmond, J. (in publication) Industrial Design and Liminal Spaces. in *Design Pedagogy* (working title), ed. Tovey, M. UK, Gower.

Osmond, J. and Clough, B. (2012) ‘Involving Assessment Buddies in the Assessment of Design Project Work’. *Design and Technology Education: An International Journal.* Vol 17, 2, 62-67

Osmond J. and Mackie, E. (2012) ‘Designing for the ‘Other’’. *DRS 2012.* held 1-4 July at Chulalongkorn University, Bangkok.

Osmond, J. and Turner, A. (2008) 'Measuring the creative baseline in transport design education'. in *Improving Student Learning – For What?.* ed. by Rust, C. Oxford: OCSLD, 87-101

Osmond, J. and Turner, A. (2010) ‘The Threshold Concept Journey: from identification to application’. in *Threshold Concepts and Transformational Learning.* ed. by Meyer, J., Land, R. and Baillie, C. Rotterdam: Sense Publishers, 347-363

Osmond, J., Bull, K., Tovey, M. (2009) 'Threshold concepts and the transport and product design curriculum'. *Art, Design and Communication in Higher Education*. 8, 2, December, 169-175(7)

Osmond, J., Turner, A., and Land, R. (2008) 'Threshold Concepts and Spatial Awareness in Automotive Design.' in *Threshold Concepts within the Disciplines*. ed. by Land, R., Meyer, J., and Smith, J. Rotterdam: Sense Publishers, 243-258

Park, E., and Light, G. (2010) 'Identifying a Potential Threshold Concept in Nanoscience and Technology: Engaging Theory in the Service of Practice.' in *Threshold Concepts and Transformational Learning.* ed. by Land, R., Meyer, J., and Baillie, C. Rotterdam: Sense Publishers, 259-279

Patton, M. (1990) Qualitative Evaluation and Research Methods (2nd ed) quoted in Sewell, M. 'The use of qualitative interviews in evaluation'. (online) Available from: http://ag.arizona.edu/sfcs/cyfernet/cyfar/Intervu5.htm. [24th September 2013]

Perkins, D. (2000) *The Eureka Affect: The Art and Logic of Breakthrough Thinking*. W.W. Norton & Co. New York. London.

Perkins, D. (1999). Quoted in Meyer, J., and Land, R. (2003) 'Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines'. in *Improving Student Learning Theory and Practice - 10 years on*. ed. by Rust, C. Oxford: OCSLD, 412-424

Perkins, D. (2006) 'Constructivism and troublesome knowledge'. *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge.* ed. by Meyer, J., and Land, R. London and New York: Routledge, 33-47

Savin-Baden, M. (2000) *Problem-based Learning in Higher Education: Untold Stories*. (online) Buckingham: SHRE and OUP, 10. Available from: http://ww.kingscourt.co.uk/openup/chapters/033520337X.pdf [Accessed 20 June 2013]

Shanahan, M. and Meyer, J. (2006) 'The troublesome nature of a threshold concepts in Economics.' in *Overcoming Barriers to Student Understanding*. ed. by Meyer, J., Land, R. London and New York: Routledge, 100-114

Shearer, B. (2004) 'Multiple intelligences theory after 20 years.' *Teachers College Record*, 106, 2-16.

Taylor, C., Liu. D., Pye. M., Tzioumis. V., Meyer. J. (2012) 'Using threshold concepts to design a first year biology curriculum.' *Australian Conference on Science and Mathematics Education*. held 26-28 September at University of Sydney. 33, ISBN Number 978-0-9871834-1-5

Tovey, M. (1984) 'Designing with both halves of the brain'. *Design Studies*, Volume 5, Number 4, 219-228

Tovey, M., Osmond, J. (2014) 'Design Pedagogy and the Threshold of Uncertainty'. *EPDE conference 2014*. 4-5 September at University of Twente, The Netherlands

Tovey, M., Bull, K., Osmond, J. (2010) 'Developing a Pedagogic Framework for Product and Automotive Design'. *Design Research Society Design & Complexity Conference*. held July 7-9 at Université de Montréal

Vgotsky, L. (1978) in Cousin G. (2008) 'Threshold Concepts, old wine in new bottles or new forms of transactional curriculum inquiry?' in *Threshold Concepts within the Disciplines*. ed. by Land, R., Meyer, J. and Smith, J. Rotterdam: Sense Publishers, 262

Vidal, R. (2009) 'Creativity for problem solvers'. *AI and Society,* Volume 23, 409-432

Wallace, K. (1992) 'Some Observations on Design Thinking'. in *Research in Design Thinking*. eds. Cross, N. Dorst, K, Roozenburg N. Netherlands: Delft University Press, 75-86

Wenger, E. (1998) *Communities of practice: learning, meaning, and identity*. Cambridge: Cambridge University Press

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Papers

Submission [1]

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JANE OSMOND, ANDREW TURNER AND RAY LAND

18. THRESHOLD CONCEPTS AND SPATIAL AWARENESS IN TRANSPORT AND PRODUCT DESIGN

INTRODUCTION

> The second assessment was more that you had to design something and that is when I struggled. And surprisingly – even though it is a design course – maybe I am more suited to a modelling background. (1st year Transport and Product Design student)

In 2005, Coventry University was successful in obtaining funding from the Higher Education Funding Council for England for the Centre of Excellence for Transport and Product Design (CETPD) under the CETL initiative. The CETL initiative has two main aims: to reward excellent teaching practice, and to invest further in that practice so that the funding delivers substantial benefits to students, teachers and institutions. The pedagogical research activity undertaken within the CETPD has three inter-related strands of enquiry: threshold concepts in design, the nature of spatial awareness and internationalisation of the design curriculum. In terms of threshold concepts in design, the pedagogical research programme is investigating ways in which students, like the student quoted at the outset, acquire, or face difficulty in acquiring, transformative threshold design concepts that are crucial for the levels of design practice required by the global transport design community. The research draws upon the continuing work of Meyer and Land (2003; 2005; 2006) into threshold concepts and troublesome knowledge.

Transport and Product Design at Coventry University is acknowledged as a centre of national excellence with claims to international prominence. The underlying philosophy of the course at Coventry is to bring students to a point where they are eligible to enter the transport design and other international product design industries. This philosophy is informed by a conceptual framework of learning drawing on notions of situated cognition and the theory of communities of practice (Wenger, 1998). Because learning within a community of practice transforms who a student is, and what a student can do, teaching staff consider participation within the programme as an experience of identity formation. The course offers more than the accumulation of skills and information, and is viewed as a process of becoming – in this case becoming a certain kind of creative and critically minded design practitioner. Through this transformative practice a

R. Land, J.H.F. Meyer & J. Smith (eds.), Threshold Concepts within the Disciplines, 243–258.

professional identity is formed, and, through the desire to become accepted within the community of creative design practitioners, learning can become a source of motivation, meaningfulness and personal and social energy. At the heart of this process is the development of spatial awareness and access to a set of knowledge practices that are necessary to visual design.

USING THRESHOLD CONCEPTS AS AN ANALYTICAL FRAMEWORK

Outcome-led approaches, in which student learning is expressed in terms of measurable cognitive outcomes, have dominated curriculum design in recent years. Davies (2003, p.2), however, considers that the creative arts are challenging with respect to outcome-led learning because 'we work with rather more ambiguous terms such as 'creativity', 'imagination', 'originality''. Creative art subjects have long been regarded as somewhat problematic in this regard, and particularly in terms of assessment, as they contain what Gordon calls the 'wow' factor' – 'creativity, originality, inventiveness, inspiration, ingenuity, freshness and vision' (2004, p.61).

Approaches to teaching used by the Transport and Product Design staff at Coventry are underpinned, in the words of one respondent, by a tacit 'underlying agenda of things the students need to have'. A large proportion of the work the students are involved in is carried out in studio conditions. As such, the working environment tends to resemble the *atelier* method of teaching which 'involves a group of students…working with one or two tutors…through a year-long cycle of design.' (Caddick and O'Reilly, 2002, p.190). Further, members of staff feel that the environment the students become part of is important in terms of feeling comfortable. This is facilitated through the enthusiasm of the staff who pass on their knowledge in the manner of an 'apprenticeship' coupled with 'respect for the creative mind' (Design Tutor).

Within the context of the Transport and Product Design course, we chose to apply the threshold concepts framework (Meyer and Land, 2006) as a lens for identifying or surfacing this 'underlying agenda of things the students need to have'. Through clarification of the knowledge practices that students must acquire, our longer term aim is then to identify pedagogic strategies for enhancing the student learning experience. Given the difficulties in expressing measurable outcomes of learning within the discipline, and the comparatively lesser degree of consensus on what constitutes the working body of knowledge, it was recognised that identifying threshold concepts could be difficult. However, according to Meyer and Land (2003, p.11), even 'where there is not such a clearly identified body of knowledge it might still be the case that what [we]have come to encapsulate in the term *ways of thinking and practising (WTP*) also constitutes a crucial threshold function in leading to a transformed understanding.'

Given the salience of spatial awareness in the process of becoming a creative and critically minded design practitioner, the CETPD research team decided to investigate perceptions of spatial understanding with both staff and students. This enabled us to open up these ways of thinking and practising in Transport and

Product Design, and, through the analysis of empirical data, to help identify threshold concepts that lead to a transformed understanding. Staff and student perceptions of what constitutes the development of spatial awareness were explored through interviews with staff and ten first-year Transport and Product Design students together with a questionnaire circulated to the whole first year intake.

SPATIAL UNDERSTANDING

A search of the literature revealed that the concept of spatial awareness has long been debated, and a number of terms are offered, including Spatial Awareness (Karnath et al. 2001), Spatial Functioning (Temple and Carney, 1995), Spatial Ability (Garg et al. 1999), Spatial Orientation (Bodner and Guay, 1997), Spatial Visualisation Ability (McGee, 1979 cited in Alias et al., 2002) and Spatial Intelligence (Eliot 2002; Gardner 1983; Shearer 2004). In this instance, we draw on Gardner:

> Central to spatial intelligence are the capacities to perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and to be able to re-create aspects of one's visual experience, even in the absence of relevant physical stimuli …spatial intelligence emerges as an amalgam of abilities. The most elementary operation, upon which other aspects of spatial intelligence rest, is the ability to perceive a form or an object …appreciating how it will be apprehended for another viewing angle, or how it would look (or feel) were it turned around …Such tasks of transformation can be demanding. The ability to solve these problems efficiently is special. (Gardner, 1983, pp.173-174).

Staff perceptions

It soon became apparent that a definitive staff view of the meaning of the term 'spatial awareness' had not yet emerged even within the context of the course. This debate over meaning was reflected during a meeting with all members of the teaching staff present, and during individual staff interviews. It was possible to group indicative responses into the following categories:

Table1. Staff perceptions of spatial awareness

Category	*Indicative response*
All around awareness	'I don't think there is any area of conscious thought about anything that the design business doesn't touch on in a way that few others do: it is this business of this incredible all-round awareness.'

Co-ordination Design sensitivity Space 'Intuitive/6th sense.' Looking at an object from the outside Mental rotation Positioning system	'Holistic approach: cloud of information with polarised areas.' 'I think spatial awareness is one of the mechanisms of this wider consciousness that people need to tap into to become a designer.' 'Awareness of where things are - boundaries where you cut off your understanding.' 'Holistic integrity.' Hand/eye/brain co-ordination.' 'Sensitivity: being able to 'see' design; some see it as a picture, others see it as presenting and manipulating information.' 'Seeing things as a whole, but having an instinct to knowing which bit to highlight to achieve certain purposes.' 'Aesthetic understanding.' 'Displacement of space.' 'Relationship between form and spaces.' 'Form-space-intelligence.' 'Intuitive/6th sense.' 'I think it really has to be looking at an object.' 'Awareness of an object at a distance.' Looking at an object from the outside rather than being in an object.' '2D to 3D translation.' 'Looking at an object at a distance, but able to perceive it in the round in detail.' 'Read views and put together in their heads.' 'Manipulation and holding things in their head.' 'Is about navigation and urban environments.' 'An awareness of space from what is occupying that space already.' 'Associated with moving through space, retaining a memory of navigation?' 'Mental markers of space that allow you to judge big or smaller spaces.' 'Spatial positioning system working on several planes.' 'Natural navigation.' 'Dead reckoning: awareness of where we are in relation to things.' 'I see it as a kind of navigational positioning where you are relative to other things…like a positioning system.'

Time	'Relates to time especially when orienting through large spaces.'
Visualisation	'Somebody being able to sit in a chair and visualise what the space around them is and look at that on drawings and have a concept of what that means.'
	'Understand what that means in terms of space around a product, car, phone etc.'
Volume	'Looking at space required around or within something.'
	'Relates to the ability to transform volume.'

Student perceptions

This lack of clarity regarding the characteristics of spatial awareness was similarly reflected during ten one-to-one interviews with students which took place in their first term. It became clear that student responses were relatively untheorised and that students did not use a disciplinary language to describe the concept. Responses to a question asking about their understanding of the term 'spatial awareness' ranged from total lack of knowledge:

- 'I can't say I do. I would like to guess but I might be wrong.'
- 'Never heard of it before.'
- 'Not a lot really.'

to a recognition of the phrase:

- 'No, I have heard the term but I am not aware of it.'
- 'I've heard of it before…'

to an approximate guess:

- 'Like distance from things and if something will fit into a certain space or if it doesn't?'
- 'In what sense – when you walk into a room and feel a lot of space?'

- 'It depends on what context you mean it in: driving a car - do you know where the other cars are or being able to rotate things in your head.'
- 'Being aware of people and things around you – taking careful look at things and understanding them.'

During the second term, a questionnaire was circulated which included a question about spatial awareness. From the noticeably more sophisticated responses to this question it appeared that the students had made some progress in their understanding:

Table 2. Student perceptions of spatial awareness

Table 2. Student perceptions of spatial awareness

Category	*Indicative response*
User needs	Being aware of design for the needs of others
Scale	Building of scale models accurately
Perspective	Helps understand dimensions and perspective for any angle
Relation of object to space	How well a product looks within the space its placed, e.g. you wouldn't put a dolls chair in a concert hall because it would be unnoticeable
Proportion	I like to look at an object and realise the proportions and why they are like that
Design sensibility	Making something look 'right' transitional form helped me with this
Observation	Noticing and constantly analysing objects around you. Shoe project - analyzed the 'make-up'
Use of space	Spatial awareness - designing the space around you
3D awareness	Spatial awareness is your ability to perceive and interpret 3D objects
Visualisation	Spatial awareness: could be described as the ability to 'imagine' how your proposed design would look, before actually representing it on paper
Ability to design from 2D into 3D	The ability to translate two dimensional sketches into three dimensional forms, i.e. models
Fit	The layout of my work - making each piece flow and work together
Drawing techniques	Through lectures, I have learnt how to draw an object from different angles from the same position

Relation of object to environment	Understanding the space around you on a particular environment and designing and modifying the components in that environment. This awareness is important when dividing perspective models

More research is to be undertaken, in particular the piloting of a test to assess students' skills in this area as they enter the course. It is hoped that findings from this test will allow the development of skills to be benchmarked and possibly to enable a greater degree of consensus on spatial awareness to be reached as it relates to this context. If this greater consensus can be reached it has been suggested that a new phrase be coined to distinguish the meaning of visual-spatial understanding in the design context when compared to phrases used by other disciplines. Suggestions have included 'Generative 3D ability', '3D creativity', 'Form-space intelligence'.

IDENTIFICATION OF THRESHOLD CONCEPTS WITHIN THE PROGRAMME

Through the discussions surrounding the notion of spatial awareness, some possible components were identified by the staff, which could be considered as threshold concepts (see below). These, it could be argued, underpin the tacit 'underlying agenda of things the students need to have':

Table 3. An articulation of candidate threshold concepts in Transport & Product Design

Possible threshold concept /practice	*Students need to be able to:*	*Threshold Concept Characteristic(s)*
Confidence to challenge/expand design clichés	inculcate design conventions and expand upon them using information from a variety of sources and experiences	Transformative Irreversible Troublesome
Empathy	to think outside of themselves and think of other people	Transformative Irreversible Troublesome
Group work	accept that designing is a team effort	Transformative Irreversible Troublesome
Language of design/designer identity	communicate using the recognised language of the design community of practice	Irreversible

Touching	understand the link between the physicality of the subject - feeling, touching, stroking, arms and bodies moving; clay, paper, resistance, different materials – enhances design skills	Transformative
Observation /perspective/ proportion/ colour	understand where they are and what they are looking at in order to draw objects in a representative manner and how colour can alter the shape of a design	Integrative
3D Visualisation to 2D representation	create a drawing and link that together as a 3D space and think about where things would be	Integrative

Some of these components were explored during the student interviews and the most troublesome appeared to be the confidence to challenge/expand design clichés. This related to the first module to be assessed, in particular to a task called the 'Thought Receptacle'. This was a reflective exercise which involved producing a diary-like item that outlined designs and objects that the students particularly liked, backed up by information as to why that was so. The task is designed to develop students' confidence to challenge existing style and practice and to foster a degree of conceptual transgression. Several students failed this task and had to re-submit. Their typical comments in relation to staff feedback included: 'really thought I had understood [the thought receptacle] – but from the feedback I hadn't. Apparently it was too planned'. Another reflected that: '[the thought receptacle] should reflect your personality and music I liked and sometimes poems and wrote down a lot of … but it wasn't much so then later on [the lecturer] said relate to design as well…the creative thing wasn't really set in.'. This was echoed by staff comments in relation to this assessment, which identified a 'limited sense of personal point of view, …distance from being a designer, lack of confidence.' As well as the fact that there was 'not much personal stuff coming through.' On the other hand one felt there was evidence of a 'Good mix of work, confident, having a go, not afraid to go into areas where she hasn't been before, confident in herself or staff to play, will find a niche eventually.'

Empathy was a problem for some of the students, particularly during the ergonomic module, which puts a high emphasis on the link between design and user needs. Some students had difficulty seeing the link. One said 'I enjoy the designing side of things but some of the other bits they are getting us to do I really don't understand the relevance of it.' Another commented: 'I came in mind to do

auto design and I think the first year was designing landscapes and development plans – not only with me but I guess with most of the students. It [the assignment] should have a bit of car in it. I suppose it might make sense later.'

Group work also proved troublesome, with some of students expressing their frustration when group members didn't turn up or pull their weight. One complained that 'we have had a lot of trouble with our first group work assignment. We were all given a user to focus on in the group work but when the day of the assessment came, two of the user groups did not turn up to set up their stuff in the morning. So out of the five user groups we only had three displays for three user groups.' Another said of a fellow group member 'when we needed the assessment in he never turned up and I had rung him and texted him and all things like that and after our assessment was over – later in the day he sent me a text saying who was this even though he knew perfectly well who it was, so that made me very cross.' One expressed dislike of the group process as a whole:'I don't really like working as a group – I don't like relying on other people – because I don't work like most others and people don't work like me and you end up with clashes.'

On the other hand, some students found that they unexpectedly enjoyed their group work: 'We had a really good group – one of the best groups I have worked in over the course of the year and everyone sort of clicked. There would be some who wouldn't turn up to the group meetings but we left them to their own devices. We bonded together and got everything sorted – actually had fun in that module'. Another, in similar vein, commented That ' the group work I enjoyed. We had a group discussion, worked out our strengths and what we felt we did best – and we went off and did that. I enjoyed that. Not everyone turned up but we did the best that we could and passed it. We just kind of discussed it [who would do what in the group] and it seemed like the best thing to do.'

The most significant progression in the students was evidenced in the development of a language of design. In order to ascertain this, the students were asked if they had to explain themselves when discussing the course with people who were not part of it:

– 'Another thing about the design language – we use it because it is a lot easier to use than – we say rendering rather than saying we did our drawing and then coloured it in, because it is a lot easier to say rendering.'
– 'It's funny you should say that because I tell people I am on the auto and product course and some people don't know what automotive is…I don't think many people would understand rendering – drawing maybe but not rendering.'
– 'I do yes…often when I am talking to my brothers about what I am doing I talk about rendering, ellipses and they are like what? I am picking it up as I go along.'
– **'**Yes, people do ask me to explain – if I am talking to people who I have gone to school with and done technology with they do know what I am talking about – but say my parents or my sisters or something they don't really know what I am

talking about sometimes. It was always like that but it has got worse since I have been on the course.'

– 'Yes, they do all the time. When I am talking to my family I sometimes wander into the design world and maybe name an artist or piece of work, and I tell them about a particular technique and they are like are you speaking alien? It is really hard work to try and explain what you are projecting onto someone who doesn't understand it.'

THE UNDERLYING EPISTEME AND CONCEPTUAL GAMES

From the staff responses in relation to the concept of spatial awareness it became clear that the skills and knowledge practices that staff impart to the students in order for them to complete the course and become successful designers remain, in the main, relatively untheorised and tacit. The lack of clarity in relation to a definitive meaning of spatial understanding in this context is perhaps because spatial awareness is, in the words of one teacher on the programme, 'Not something that designers acknowledge or talk about because it is the natural world they inhabit.' Another commented that 'it is an intuitive skill you develop, especially through experience.' Significantly the staff felt that '*is not a single threshold concept: there are components that result in this*.' This was possibly attributed to the fact that the course does 'not explicitly explore spatial awareness'.

These latter responses provide an interesting illustration of the important distinction David Perkins has made between threshold *concept* and underlying *episteme*. He points out that 'Although some of what is troublesome about knowledge squarely concerns the categorical function of concepts, much concerns the larger conceptual games around them' (2006, p.41). He cites as an example the difference a history student might experience between coming to understand, on a conceptual level, the notion of bias when examining historical sources, and actually having to consult and use historical sources whilst keeping her critical antennae alert to the possibility of bias, and making appropriate allowance for the effects of bias when it is encountered. The former might remain at the level of inert knowledge whilst the latter most definitely would constitute an active knowledge practice. 'As with inert knowledge,' he argues, 'so with ritual, conceptually difficult, foreign, and tacit knowledge – these troubles have as much to do with the activity systems that animate concepts as they do with concepts in their basic categorical functions' (p.41). Besides recognising what he terms 'the games of enquiry we play' with particular concepts, it is, he argues, important to look beyond the particular. 'The disciplines', he states, 'are more than bundles of concepts. They have their own characteristic *epistemes*.' (Perkins, 2006, pp.41-42)

Perkins provides a helpful definition of an episteme as:

> a system of ideas or way of understanding that allows us to establish knowledge. Schwab (1978) and Bruner (1973) among others have emphasised the importance of students understanding the structure of the disciplines they are studying. 'Ways of knowing' is another phrase in the

> same spirit. As used here, epistemes are manners of justifying, explaining, solving problems, conducting enquiries, and designing and validating various kinds of products or outcomes. (Perkins 2006, p.42)

Each discipline brings with it its own distinctive episteme and distinctive form of validation. Perkins points out that in various sub-disciplines of Engineering, for example, 'effective designs find their validation in not just sets of principles but practical performance from prototypes to wide-scale field tests' (p.42).The design tutors we interviewed often indicated their sense that what design students required to enter the design community of practice, and to think and practice like a designer, was 'not a single threshold concept' but 'components that result in this'. What characterises the 'this' that is referred to seems to be primarily a nexus of attributes that are *integrated*. 'It is this business of this incredible all-round awareness' one respondent remarked. Another felt it was a 'holistic approach', a 'cloud of information with polarised areas.' Yet another felt the designer needed a capacity for 'holistic integrity.' Spatial awareness, some tutors felt, was an important 'component' – 'Awareness of where things are, boundaries where you cut off your understanding.' – but only one component of this broader epistemic fluency. 'I think spatial awareness is one of the mechanisms of this wider consciousness that people need to tap into to become a designer.' This underlying episteme of design appears to be a powerful and ever-present determinant of subjectivity: 'I don't think there is any area of conscious thought about anything that the design business doesn't touch on in a way that few others do'. This, too, resonates with Perkins' (2006) observation that 'threshold concepts certainly include more than particularly tough conceptual nuts in the content of a discipline. There are threshold epistemes that shape one's sense of entire disciplines' (p.44).

The empirical data from our interviews with Design staff and students highlighted the troublesome nature of *tacit* understandings in the teaching of spatial awareness in design contexts. This seems to concur with Perkins' own findings.

> Perhaps tacit knowledge is the most pervasive trouble with epistemes. Many teachers play the epistemic games of their professional disciplines fluently and automatically, and successful students ultimately need to do so as well. The problem is, many students never get the hang of it, or only slowly, because the epistemes receive little direct attention. For [students], surfacing the game through analytic discussion and deliberative practice could make a big difference. (2006, p. 43)

Davies (2006), researching into the learning of Economics, comes to similar conclusions. He points out that a threshold concept is very likely to be troublesome because 'it not only operates at a deep integrating way in a subject, but it is also taken for granted by practitioners in a subject and therefore rarely made explicit' (p.74). He, too, rejects the reductivist notion that the knowledge practices of a disciplinary community can be represented in terms of a skill set or 'bundle of concepts' in Perkins' phrase. He cites Mitchell (2001) who emphasises 'ideologies' as they relate to disciplinary thinking:

> It is the way in which such concepts are related, the deep-level structure of the subject which gives it coherence and creates a shared way of perceiving that can be left unspoken. This shared way of perceiving is the ideology of a subject, 'the invisible structures and beliefs by which we operate and which appear as natural unchallengeable ways of doing things' (Mitchell, 2001, p. 2, cited in Davies, 2006 p.71).

So in addition to their categorical functions, threshold concepts seem to be entangled with a much wider pattern of practice and enquiry, a set of games that are played with the concepts, and which in turn can provide a further source of troublesomeness for the novitiate. Within transport and product design, students seem to be required, *inter alia*, to gain sophisticated three-dimensional spatial understanding, and to nest this within a streetwise and sophisticated cultural sensitivity to prevailing taste, style and fashion. At the same time their designs draw on these spatial understandings and cultural antennae, they must also on the one hand conform to the material, cost, efficiency, environmental and safety constraint,of the industry (referred to within the community's discourse as 'packaging') *and* surprise and pleasantly shock their tutors through a degree of conceptual transgression which ensures that their creative work does not replicate the styles and norms of the older generation of their tutors. Where the expected or permissible boundaries of such transgression lie remains tacit and implicit. The shock of the new, yes, but they still need to pass. And the examiners are the older generation. This is something of a tall order and entails a complex process of enculturation if the students are to eventually make it in the design world. These necessary disciplinary understandings and attributes might be presented diagrammatically as in Figure 1.

ENTERING THE COMMUNITY OF DESIGN

So how might design students gain sufficient understanding of the 'underlying agenda of things the students need to have'? The Coventry programme draws these students into a state of 'liminality' (Meyer and Land, 2005), an in-between state of uncertainty and insecurity in which they do not enjoy full community membership status and struggle both to make sense of the underlying episteme and also to find their own creative identities as design practitioners. Perkins draws attention to 'the toolkit fallacy' which maintains that 'providing the students with the toolkit of explicit heuristics would enable their effective use'. He argues that this is insufficient:

> instead, it was found that students also needed a self-management strategy to monitor their deployment of heuristics and their progress. Moreover, it was not enough for teachers to work model problems, they had to comment directly on the heuristics as they were deployed so students gained a situated sense of their utility. The combination of a self management strategy and explicit modelling yielded a dramatic improvement in students' ... problem solving. (2006, p.43)

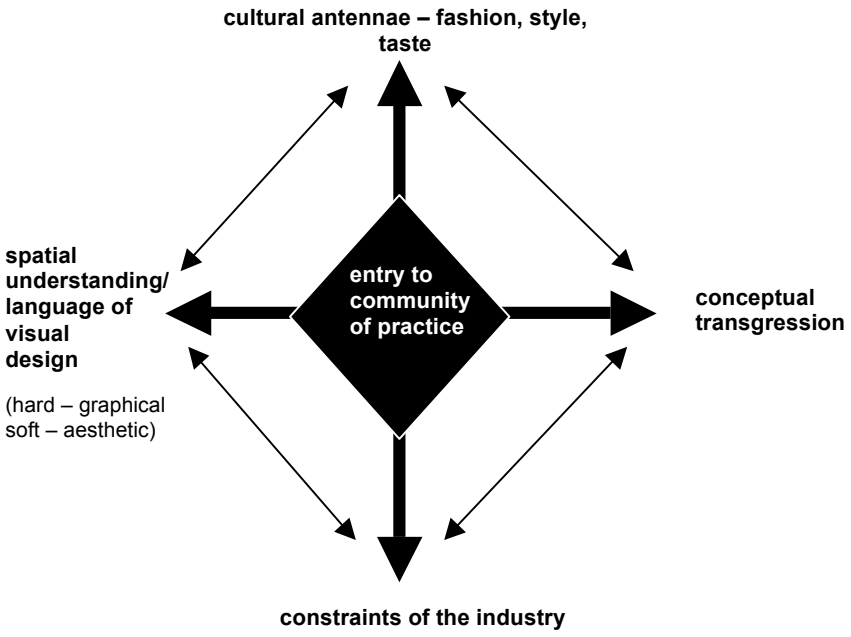

Figure 1. A conceptualisation of the transport & product design student's disciplinary enculturation.

The threshold concepts framework (Meyer and Land, 2006) also emphasises that the act of learning is an act of identity formation, and that entrance to a particular discourse community and the ways of thinking and practising particular to that community involves integrated transformations in language, identity and conceptual structure. But as Davies maintains, immersion in the ways of the community is necessary but insufficient.

> A student can accumulate knowledge about a community and the ideas that are commonly accepted in that community, but this falls short of acquiring the way in which members of that community see the world. When asked to explain a given theory, or to cite extracts from a body of received knowledge, they may be able to do this perfectly well. But when asked to look around them they do not see the world as viewed by a member of a subject community. (Davies, 2006, p.71)

Seeing the world as viewed by a member of a subject community also requires an affective transformation, or the gaining of what Cousin (2006) has termed 'emotional capital'. The liminal state encountered within the Transport and Product Design programme provides space for the development of a self-management

strategy in the terms Perkins speaks of. The liminal state, a place of transition, uncertainty and hybridity, can also be a space for resistance and the assertion of difference (Bhabha 1998). In terms of identifying threshold concepts, it is possible that the problem with the thought receptacle task discussed earlier, which relates to the possible threshold concept of 'confidence to challenge' (conceptual transgression), was that the students were not yet confident in their own abilities and had not yet reached the stage where they felt confident in expressing their own ideas. One member of staff identified students who 'reach the point where being creative is not possible, can't think beyond the box'. This proved troublesome for one student who performed well in the first assignment but not in the second, and expressed her uncertainty about carrying on with the course because:

> the second assessment was more you had to design something and that is when I struggled. And surprisingly – even though it is a design course – maybe I am more suited to a modelling background. (1st year design student)

Here the conceptual barrier prevents access to an identity that is desired by the student (designer) and brings into view an alternative subjectivity which seems less desired and less satisfying (modelling). It is also possible that the problem with the group work was that the students who did not turn up for their meetings were not willing to accept that designing is a team effort, and therefore had not reached the possible threshold concept stage of the maturity (emotional capital) to accept such a constraint. In both instances, the troubled transition to a particular conceptual structure inhibits transformation to a more developed identity and access to the community of practice. What is particularly troublesome in these instances is that the underlying episteme necessary for these students to move on does not even come into view. This argues strongly for a mode of pedagogy which can render these less accessible knowledge practices more visible and explicit so that they can become the focus of discussion and exploration between deign students and their tutors. 'Without this openness' suggests Davies, 'the interaction between teachers and learners is shrouded in a mystery that ultimately deprives many learners of an opportunity to experience the way of thinking and practising that is apparently being offered to them. They just cannot see it' (Davies, 2006 p.71).

CONCLUSION

Using the threshold concept framework has enabled the research team to open up a dialogue with teaching staff in a discipline that appears, in the main, to be relatively undertheorised. The usefulness of this dialogue was evidenced – during the whole-staff meeting and in individual interviews – by the enthusiasm of staff to participate. The Design tutors, as reported earlier, felt that there was an underlying agenda of things the students needed to experience before they could become successful designers, but our initial investigations found that this underlying agenda had previously not been articulated clearly. This could speak to the nature of the subject, in that creative arts subjects are not easily quantifiable, with regard to learning outcomes and especially in assessment terms.

In addressing the original research question relating to spatial awareness, the first year of research by the CETPD team has found considerable variation in first year Design students' understanding of spatial issues. As the course progressed, the students were beginning to formulate more sophisticated understandings of spatial matters, but the variation in their understanding at this stage did not appear to be particularly influenced by age, gender or culture. Further research to address patterns of variation will take place in the form of a longitudinal study following the original group of ten student interviewees through their four-year programme. A research methodology is planned that intends to gain insights into variation in the pre-liminal, liminal, post-liminal and sub-liminal (epistemic) dimensions of their development of spatial awareness in line with the model proposed by Meyer, Land and Davies (2006). Throughout this continuing study the research will focus on the following issues:

– what is the student understanding of spatial awareness (and other relevant threshold concepts) in the first year of entry?
– how might factors such as age, gender and culture influence this understanding?
– what patterns of variation in the development of conceptual understanding relating to spatial design issues are discernible across subsequent years of the programme?

Findings from the data analysis will be used to explore, with the Design staff, the relative advantages and limitations of the *atelier* method as a learning environment for the development of spatial awareness and other related concepts necessary for the successful education of automotive design practitioners.

REFERENCES

Alias, M., Black, T., Gray, D. (2002) 'Effects of Instructions on spatial visualisation ability in civil engineering students.' in *International Education Journal* Vol. 3, No. 1

Bhabha, H. (1998) Culture's in between. In Bennet, D. (Ed.) *Multicultural states: Rethinking difference and identity*. London:Routledge. pp 29-26

Bodner, G., Guay, R. (1997) 'The Purdue Visualization of Rotations Test.' in *The Chemical Educator*. Vol. 2, No. 4 pp1-17.

Caddick, M. and O'Reilly, D (2002) 'Structures for facilitating play and creativity in learning: a psychoanalytical perspective' in Wisdom, J. *Academic and Educational Development: Research, Evaluation and Changing Practice in Higher Education*. London: Kogan Page..

Cousin, G. (2006) Threshold concepts, troublesome knowledge and emotional capital: an exploration into learning about others. In Meyer, J.H.F. and Land, R. (eds) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge.* London and New York: Routledge..

Davies, A. (2003) Writing learning outcomes and assessment criteria in art and design. Report for the Art, Design and Communication Learning and Teaching Support Network (ADM Subject Centre) 2000 / 2001. http://www.brighton.ac.uk/adm-hea/projects/adm-projects/effect-assess-ad.html. Accessed: August 14th 2006

Davies, P (2006) Threshold concepts: How can we recognise them? In Meyer, J.H.F. and Land R. (Eds.) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge. pp 70-84.

Eliot, J. (2002) 'About Spatial Intelligence: I [1,2'] *Perceptual and Motor Skills*, 94, 479-186.

Gardner, H. (1983) *Frames of mind: the theory of multiple intelligences*. New York: Basic Books

Garg, A., Norman, G., Spero, L., Taylor, I. (1999) 'Learning anatomy: do new computer models improve spatial understanding?' in *Medical Teacher*, Vol. 21, No. 5

Gordon, J. (2004) 'The 'wow' factors: the assessment of practical media and creative arts subjects' in *Art Design & Communication in Higher Education.* Vol 3. Number 1. Bristol Intellect Publishing

Karnath, H., Ferber, S., and Himmelbach, M. (2001). 'Spatial awareness is a function of the temporal not the posterior parietal lobe.' *Nature*, Volume 411(6840): pages 950-953

McGee, M (1979) *Human Spatial Abilities: Sources of Sex Differences*. New York: Praeger,

Meyer, J.H.F. and Land, R. (2003). Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines. In C. Rust (Ed.), *Improving Student Learning. Improving Student Learning Theory and Practice — 10 years on*, OCSLD, Oxford, 412-424.

Meyer, J.H.F. & Land, R. (2005). Threshold concepts and troublesome knowledge (2): epistemological considerations and a conceptual framework for teaching and learning. *Higher Education*, 49 (3) 373-388.

Meyer, J.H.F. and Land R. (Eds.) (2006). *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge.

Meyer, J.H.F., Land R. and Davies, P.(2006) Threshold concepts and troublesome knowledge (4):issues of variation and variability. Paper delivered at the *Threshold Concepts within the Disciplines Symposium*, Glasgow UK. 1 September.

Mitchell, S. (2001) Some key concepts in argument, in Andrews, R and Mitchell, S. (Eds) Essays in Argument. London: Middlesex University Press.

Perkins, D. (2006) Constructivism and Troublesome Knowledge in Meyer, J.H.F. and Land R. (Eds.) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge. pp 33-47.

Shearer, B. (2004) 'Multiple Intelligences Theory after 20 Years.' in *Teachers College Record.* Vol. 106, no. 1 pp2-16

Temple. C., Carney, R. (1995) 'Patterns of spatial functioning in Turner's syndrome.' *Cortex*. 31(1):109-18.

Wenger, E. (1998) *Communities of practice: learning, meaning and identity*. Cambridge: Cambridge University Press

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Osmond, J. and Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust., C. (ed) *Improving Student Learning – For What?* Oxford: OCSLD, 87-101

Measuring the creative baseline in transport design education

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Abstract

This paper focuses on how using Meyer and Land's (2003) notion of threshold concepts as a research framework facilitated the exploration of spatial awareness development, which could be considered as the existing creative baseline of the Transport and Product Design course at Coventry University.

Meyer and Land define threshold concepts as concepts that: '...can be considered as akin to a portal, opening up a new and previously inaccessible way of thinking about something. They represent a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress.' (2003). Spatial awareness was presented for discussion to both staff and students as a potential threshold concept.

Initial research highlighted differences in perceptions between course team members and between students of spatial awareness, which reflected the literature in which several phrases and definitions are offered (see Karnath et al. 2001; Garg et al. 1999; Bodner and Guay, 1997; Eliot, 2002; Gardner, 1983; Shearer, 2004). These discussions allowed the identification of several possible threshold concepts which informed the development of a pilot measurement tool which, in conjunction with Bodner and Guay's Purdue Visualization of Rotations Test (1997), was administered to first year students in October 2006.

The aim of the tests was to ascertain if there was a correlation between student scores on the measurement tool on entry to the course and end-of-year assessment results. With such a correlation, pedagogic interventions could then be targeted at those students who perform relatively poorly on the tests at entry. Conversely, if there was no correlation, then a question would need to be raised about the centrality of spatial awareness to the first year of study: perhaps another definition of spatial awareness, or the 'creative baseline', would need to be found.

No correlation between first year student scores on the measurement tools and end-of-year assessment results was found, although there was some correlation between the results of both tests, indicating that they did indeed measure similar aspects of students' spatial abilities. However, as this bore no relation to assessment results, more research is needed in identifying the key threshold concepts on the course. Early indications are that the 'confidence to challenge', possibly akin to Perkins' idea of 'breakthrough thinking', is a potential threshold concept. More research to investigate whether the 'confidence to challenge' is a threshold concept is to take place and may well help to unearth what one member of staff described as the 'underlying agenda of things we know the students need to have', that is at the heart of a very successful course

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Introduction

The notion of *Threshold concepts* was first introduced by Meyer and Land (2003) to characterise the idea that in certain disciplines there are concepts that "represent a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress". Threshold concepts are often likened to a portal or conceptual gateway in that they open up a new and previously inaccessible way of thinking about something. Such concepts may be transformative, irreversible and integrative in the way they change how people think in a discipline or perceive particular phenomena. The discourse around threshold concepts builds and draws upon Perkins' idea of *troublesome knowledge* – knowledge that is 'alien', or counter-intuitive or even intellectually absurd at face value (Perkins, 1999). A threshold concept may on its own constitute, or in its application lead to, such troublesome knowledge (Meyer and Land, 2003).

Since the notion of threshold concepts was described by Meyer and Land, they have been identified across diverse disciplines. For example, the relationship between cash and profit and the concept of depreciation in accounting (Lucas and Mladenovic, 2006), the concept of caring for student health professionals (Clouder, 2005). and the concept of 'Otherness' in communication studies (Cousin 2006) The emergent body of literature around threshold concepts clearly demonstrates that the notion is one that resonates with many researchers and is applicable across diverse disciplinary boundaries.

The thresholds concepts framework has been applied as a lens to research into the Transport and Product Design Courses at Coventry University in order to identify key concepts that students need to acquire in their development as designers and enter the transport and other international product design industries (Osmond et al., 2007). Conceptually, this philosophy draws upon notions of situated learning and the communities of practice theory (Wenger, 1998).

Threshold concepts as a research framework

At the outset of the research it was clear that in relation to pedagogical theory, the Transport and Design discipline was relatively untheorised, and, as Cousin found in her study of Communication, Culture and Media discipline, it looked '...like a disciplinary area which is likely to resist the construction of a taxonomy of stable threshold concepts.' (2006:134). As reported by Osmond et al., (2007), the approaches to teaching used by the Transport and Product Design staff were found to be underpinned by a 'tacit underlying agenda of things that students need to have' (design tutor), and the working environment of the course was found to resemble the *atelier* method of teaching (Craddick and O'Reilly, 2002) with staff enthusiastic to pass on their knowledge in the manner of an 'apprenticeship' coupled with 'respect for the creative mind' (design tutor).

Existing literature based on phenomenographic research relating to approaches to study or teaching were found to have little relevance to both staff and students on the course. For example, pilot studies employing the Experiences of Teaching and Learning Questionnaire (ELTQ 2002) developed from the ESRC-TLRP project "Enhancing Teaching-Learning Environments in Undergraduate Courses" found the notions of deep and surface learning not to be particularly applicable to the course, with the questionnaire itself found to be both too atomistic and generic a tool.

Therefore, the thresholds concept framework provided a very useful starting point for opening up a dialogue with both students and staff. Staff in particular engaged enthusiastically with the pedagogical research team in both interviews and whole-staff meetings and found the thresholds approach accessible in terms of both a theoretical concept and the language.

Spatial awareness: a threshold concept?

As staff posited that spatial awareness was the creative baseline - defined as the common thread that underpins the course - a research question - 'is spatial awareness a threshold concept for the Transport and Product Design course?' - was formulated. A concomitant research aim was to develop a discipline specific tool to measure student conceptions of spatial awareness on entry to the course and correlate this with their end of year assessment results. The tool could then be used to inform pedagogical interventions for students who struggled in this area.

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A key finding to emerge from a whole-staff meeting and individual interviews with staff was the lack of a common definition of perception of spatial awareness. In many ways this reflected the numerous definitions presented in the published literature (Bodner and Guay 1997, Eliot 2002, Gardner 1983, Garg et al. 1999, Karnath et al. 2001, Shearer 2004). Osmond et al. (2007) grouped staff perceptions of spatial awareness into 11 categories through the analysis of interview and meeting transcripts (Table 1). These included mental rotation, design sensitivity, positioning systems and visualisation.

Table 1: Categories of staff perceptions of spatial awareness (from Osmond *et al.* 2007)

Category	**Indicative response**
All around awareness	'I don't think there is any area of conscious thought about anything that the design business doesn't touch on in a way that few others do: it is this business of this incredible all-round awareness.'
	'Holistic approach: cloud of information with polarised areas.'
	'I think spatial awareness is one of the mechanisms of this wider consciousness that people need to tap into to become a designer.'
	'Awareness of where things are - boundaries where you cut off your understanding.'
	'Holistic integrity.'
Co-ordination	'Hand/eye/brain co-ordination.'
Design sensitivity	'Sensitivity: being able to 'see' design; some see it as a picture, others see it as presenting and manipulating information.'
	'Seeing things as a whole, but having an instinct to knowing which bit to highlight to achieve certain purposes.'
	'Aesthetic understanding.'
Space	'Displacement of space.'
	'Relationship between form and spaces.'
	'Form-space-intelligence.'
'Intuitive/6th sense.'	'Intuitive/6th sense.'
Looking at an object from the outside	'I think it really has to be looking at an object.'
	'Awareness of an object at a distance.'
	Looking at an object from the outside rather than being in an object.'
Mental rotation	'2D to 3D translation.'
	'Looking at an object at a distance, but able to perceive it in the round in detail.'
	'Read views and put together in their heads.'
	'Manipulation and holding things in their head.'
Positioning system	
	'Is about navigation and urban environments.'
	'An awareness of space from what is occupying that space already.'
	'Associated with moving through space, retaining a memory of navigation?'
	'Mental markers of space that allow you to judge big or smaller spaces.'
	'Spatial positioning system working on several planes.'
	'Natural navigation.'
	'Dead reckoning: awareness of where we are in relation to things.'
	'I see it as a kind of navigational positioning where you are relative to other things…like a positioning system.'
Time	'Relates to time especially when orienting through large spaces.'
Visualisation	'Somebody being able to sit in a chair and visualise what the space around them is and look at that on drawings and have a concept of what that means.'
	'Understand what that means in terms of space around a product, car, phone...'
	'Looking at space required around or within something.'
Volume	'Relates to the ability to transform volume.'

This lack of a common definition of spatial awareness was reflected in interviews with students. On entry onto the Transport and Product Design course some students displayed a total lack of knowledge relating to the term 'spatial awareness' whereas others could provide an approximate guess. As students progressed with their course they provided more sophisticated definitions of the term. However, as with staff, there was a lack of a common definition with a total of 14 different categories identifiable from interview transcripts. Osmond and Bull (2007) concluded that notion of spatial awareness was unlikely to be a threshold concept in itself but more of a meta-concept underpinned by a number of potential threshold concepts (Table 2).

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Table 2: Possible threshold concepts (from Osmond *et al.* 2007)

Potential threshold concept	Students need to be able to:	Threshold Concept Characteristic(s)
Confidence to challenge/expand design clichés	inculcate design conventions and expand upon them using information from a variety of sources and experiences	Transformative Irreversible Troublesome
Empathy	to think outside of themselves and think of other people	Transformative Irreversible Troublesome
Group work	accept that designing is a team effort	Transformative Irreversible Troublesome
Language of design/designer identity	communicate using the recognised language of the design community of practice	Irreversible
Touching	understand the link between the physicality of the subject - feeling, touching, stroking, arms and bodies moving; clay, paper, resistance, different materials – enhances design skills	Transformative
Observation /perspective/ proportion/ colour	understand where they are and what they are looking at in order to draw objects in a representative manner and how colour can alter the shape of a design	Integrative
3D Visualisation to 2D representation	create a drawing and link that together as a 3D space and think about where things would be	Integrative

Development of the pilot measurement tool

Although a common whole-staff definition of spatial awareness could not be derived, there were common elements - or possible threshold concepts - identified (Table 2) which contributed to the development of spatial awareness, some of which were incorporated into a pilot Transport and Product Design Test (TPD© Test). The TPD Test, developed by staff and the research team, required students to complete a series of drawing tasks within a limited time period with the tasks designed to demonstrate skills in spatial awareness (Figure 1).

Figure 1: TPD Test

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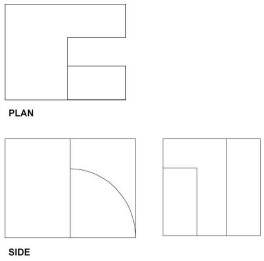
Task	
Draw a simple cube at a size you feel comfortable with (5 minutes)	
Draw the object (boxes or bin) in front of you from the angle you can see (5 minutes)	
Draw this object in 3D from the authographic views. (5 minutes)	
Draw the unseen side of the chair in front of you. (5 Minutes)	

The TPD Test was used alongside an established published test: *The Purdue Visualization of Rotations Test* (*PVRT)*, which was originally developed by Bodney and Guay (1997) and specifically designed as the basis for evaluating courses developed to enhance students' spatial skills. In addition, the developers of the test maintain that it can be used to examine students' perceptions of computer-based learning activities that require them to perceive three-dimensional structures from two-dimensional representations on a computer screen. This focuses primarily on gestalt processing (transforming visual images as a whole, rather than breaking down the whole and re-mapping the relationships) which is commonly accepted as the main component of spatial ability. The test comprises a series of 20 questions which the student completes within 10 minutes. The directions for the test tell the student to study how the object in the top line of each question is rotated, picture in their mind what the object shown in the middle line of the question looks like when rotated in exactly the same manner, and select from among the five drawings (A to E) given in the bottom line of the question the one that looks like the object rotated in the correct position (Figure 2).

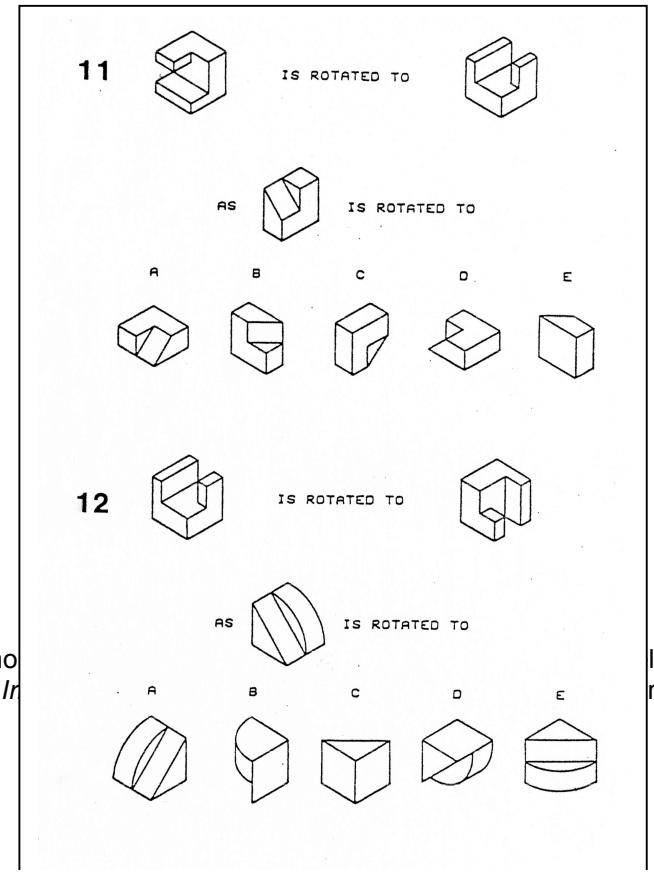


Figure 2: Example questions taken from the Purdue Visualization of Rotations Test (Bodner and Guay 1997)

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First year students on the 2006 intake of Transport and Product design courses completed the *PVRT* and TPD Tests under supervised conditions. The tests were undertaken by 114 students, and a total of 105 completed tests were marked. All the courses shared a number of common mandatory modules during the first year allowing a comparison of the spatial awareness tests scores with student module marks. The *PVRT* was marked according to the test marking scheme provided, and the TPD Test was marked by the research team and Industrial Design staff.

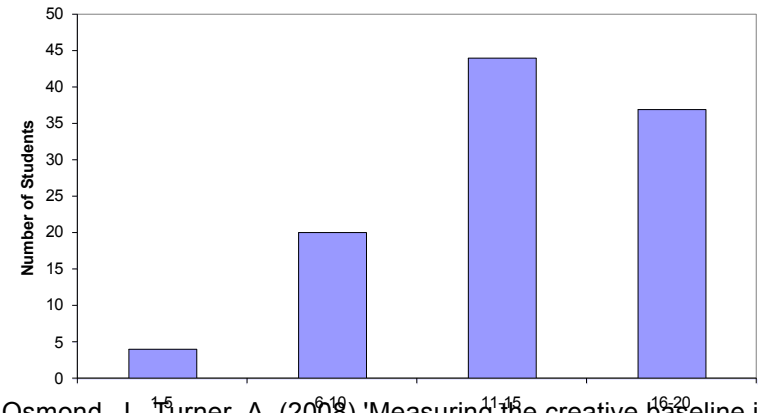
Test Results

Statistical analysis of the results was conducted using SPSS™ statistical software (version 14.0). Data were checked for normality before the calculation of mean scores. Correlations were carried out using Pearson and Spearman Rank tests as appropriate (Ho, 2006).

An overall mean *PVRT* score of 13.43 (±0.40 S.E.) was obtained for all students. Most students (42%) scored between 11 and 15; 35% scored between 16 and 20 with 23% scoring 10 or less (Figure 3). The mean score is similar to those obtained in published data on the use of the *PVRT* undertaken by chemistry students at Purdue University (Bodner and Guay, 1997) (Table 3). Tests at Purdue University were carried out with larger cohorts of students than at Coventry and direct comparisons should be made with caution, however the similarity in mean performance and standard error provides some verification of the robustness of the test. The low number of female students on the Coventry courses meant that no conclusions could be drawn as to the performance of female students compared with male students.

The TPD Test was scored out of a total of 80. A total of 29 TPD Tests were selected that represented the range of *PVRT* score results achieved by the students. A mean score of 42.59 (±2.61 S.E.) was obtained from the marked internal score tests. The TPD Tests results were significantly correlated with the Coventry results from the *PVRT* ($r = 0.419$, $p<0.05$; Spearman rank-order coefficient rho $=0.459$, $p< 0.01$) suggesting that two tests assess similar aspects of spatial awareness, albeit across two completely different disciplines.

Figure 3: Distribution of Purdue test Scores. The test was marked out of 20.



Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

The data was explored to establish whether performance in either test was related to student performance on their course of study and it was found that there was no correlation between whether a student passed or was referred on their course of study at the end of the year and their *PVRT* or TPD Test scores. Student end of module marks from a mandatory module in 2D and 3D Representation common to all Transport and Product Design courses were then compared, firstly to their performance in the *PVRT* and then to the 29 TPD Test results. There was no correlation between student module marks on the mandatory module and the *PVRT* ($r = 0.166$, $p>0.05$) or the TPD Test ($r = 0.267$, $p>0.05$). Of the students that were referred in their course of study, virtually all the students passed their mandatory module in 2D and 3D Representation suggesting that in their first year of their courses, at least, students demonstrated a sufficient level of skill in spatial awareness to progress. In many ways, this result is not surprising as the course entry selection procedure is - in-part - based on a submitted representational portfolio of work where the demonstration of skills in spatial awareness.

Table 3. Number of students, mean and standard deviation for the *PVRT* completed by students at Purdue University and compared with Coventry results. Data other than Coventry University derived from (Bodner and Guay, 1997).

Population	N	Mean	Standard Deviation
General chemistry course of science/engineering majors	1273	13.84	3.84
General chemistry course of science /of science engineering majors	1648	13.96	3.80
Sophomore organic course for biology/pre-med majors	158	14.16	3.78
General chemistry course for agriculture/health science majors	757	12.49	4.08
General chemistry course for agriculture/health science majors	850	11.66	3.96
Sophomore organic course for agriculture/ health science majors	127	12.35	4.02
Coventry University Transport and Product Design Courses	105	13.43	4.05

The lack of any correlation between performance in the *PVRT* and TPD Tests and performance on the course suggest that the elements of spatial awareness that are measured through the tests are not explicitly assessed in the first year of the course but that the students possess a baseline level of skills or creativity sufficient to underpin their assessments. This does not mean that spatial creativity is not important or not developed and clearly students who enter the course have demonstrated the necessary creative ability or 'creative baseline' as discussed by Osmond and Bull (2007). Those who scored poorly in the *PVRT* did not score poorly in their course assessments. The results from students undertaking the *PVRT* and TPD Test further strengthen the suggestion that spatial awareness is not a threshold concept in itself but a required skill which may underpin other potential threshold concepts. In Osmond *et al.* (2007) a member of the course team commented that spatial awareness '...is not something that designers acknowledge or talk about because it is the natural world they inhabit' which supports this view.

Discussion

As the findings have shown, staff felt that spatial awareness development was not a threshold concept, and no correlation between first year student scores on the measurement tools and end-of-year assessment results was found. However, this is not to say that spatial awareness it not a crucial component in the success of students' journey towards to the identity of 'designer' and concomitant entry into the design community of practice. In other words, it is possible that spatial awareness development becomes of more importance in subsequent years of study and may well become a threshold concept at a different stage of the course. At this point, though, it is posited that *spatial awareness development is not a threshold concept in the first year of study.*

Therefore, it has to be considered what the key threshold concepts for the first year of study are. As previously detailed in this paper, a number of possible threshold concepts were identified (Table 3) during the research process and one in particular seems to be emerging as contender. Originally labelled

Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

‘confidence to challenge/expand design clichés’ and defined as students needing the ability to ‘inculcate design conventions and expand upon them using information from a variety of sources and experiences’, a notion that is gaining currency is that the ‘confidence to challenge’ may be akin to Perkins’ idea of ‘Breakthrough Thinking’.

Breakthrough thinking ‘...basically concerns creativity - the kind of creativity that involves thinking outside the box. It's thinking that leads to fundamental discovery or invention in science, in historical scholarship, politics, business, or really any context at all’ (Perkins, 2000). Moreover, Perkins divides the process of breakthrough thinking into five stages: 1) a long search, 2) little apparent progress, 3) precipitating event, 4) cognitive snap and 5) transformation, which resonate with Meyer and Land’s definition of a threshold concept: ‘a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress...often likened to a portal or conceptual gateway in that [it opens] up a new and previously inaccessible way of thinking about something.’

Further, the work of Davies and Mangan (2007) on threshold concepts in economics may well be pertinent, in particular their distinctions between types of conceptual change (Table 4).

Table 4: Definition and exemplification of three types of conceptual change (Davies and Mangan 2007)

Type of conceptual change	Type of transformation and integration	Examples in economics
1. Basic	Newly met concepts some of which transform understanding of everyday experience through integration of personal experience with ideas from discipline.	Distinctions between price/cost; income/wealth (stocks/flows); nominal/real values; investment/saving. Real money balances, natural rate of unemployment.
2.Discipline Threshold concepts	Understanding of other subject discipline ideas (including other threshold concepts) integrated and transformed through acquisition of theoretical perspective	Interaction between markets, welfare economics, opportunity cost
3. Procedural (in the case of economics: how are models of the economy constructed and evaluated)	Ability to construct discipline specific narratives and arguments transformed through acquisition of ways of practising.	Comparative statics (equilibrium, ceteris paribus), time (short-term, long-term, expectations), elasticity

In the context of the transport and product design discipline, the ‘confidence to challenge’ would fit into the third type of conceptual change (Procedural) in that the students gain the ability to tackle what Buchanan (1992) calls ‘wicked problems’, which ‘...have incomplete, contradictory, and changing requirements; and solutions to them are often difficult to recognize as such because of complex interdependencies.’ In other words, once they have reached this stage, successful students can tackle these ‘wicked problems’ and produce new and original designs which can be defended from a position of knowledge gained from the journey through the previous (basic and threshold concept) conceptual changes.

Evidence to support this emerging possible first year threshold (or procedural) concept can be found from a number of sources, including staff perceptions, data from student interviews which show that some students have struggled with a curriculum that emphasises individual agency, and assessment results which show that the Personal Development Portfolio (PDP) module, which privileges a style of thinking akin to Perkins’ definition, have caused difficulty for some.

In particular, one student evidenced difficulty with successfully negotiating the journey towards the ‘confidence to challenge’ from entry to the course in 2005 when faced with a task entitled the ‘thought receptacle’. This was a reflective diary-like exercise that the students were expected to fill with designs and objects that they particularly liked, backed up by information as to why that should be so. This task was the forerunner to the PDP module, in that it was designed to develop the confidence to challenge existing style and practice and to foster a degree of conceptual transgression (Osmond et al. 2007):

Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

'There was one I was disappointed with [thought receptacle] lots of different things – apparently it was too planned - previously we had been told if you want to put everything in a box – and then stick it in a book after and then organise it - its fine – I like to organise – can't help that. Too organised – is that a bad thing? Wasn't really a design thing it was just collecting objects so I thought – this has to be here and organised.

It seems that this student could not get over an 'organisational barrier', and as the quote below suggests, creativity remained elusive during his second year:

If it is someone else's drawings you can bring it to life and it is a lot easier. I didn't struggle so much with the first assessment – the 2nd assessment was more you had to design something and that is when I struggled...even though it is a design course.

In other words this student could not seem to 'make the creative leap' necessary to begin the journey towards the identity of designer, even though his assessment marks (he passed both the first and second year of his course with relatively high marks) belied this.

The experience of this student seems to indicate that he got 'stuck' at Davies and Mangan's 'discipline threshold concept stage' in that although he had successfully 'learned' the basics and the theory (according to his assessment results), he could not then make the leap of confidence to the procedural stage and use what he had learnt to produce and defend original designs. As such he can be considered to have been stuck in a pre-liminal state, unable to incorporate what he had learned into the way he saw himself and his identity did not move on from 'student' towards 'designer'.

At this point, then, the notion of the 'confidence to challenge' in the context of the Transport and Product Design course is to be explored in depth over the next academic year, in terms of its components and processes. Results from the research will then be used to inform course design, and may well also inform the development of a new creative baseline for the first year of the Transport and Product Design course. If such a baseline can be identified it may be possible to develop pedagogical interventions to enhance student learning and achievement.

Conclusion

This paper has focused on the outcome of research into first year students' spatial awareness development, seen as the creative baseline of the Transport and Product Design course at Coventry University, using Meyer and Land's notion of threshold concepts as a research framework.

Using the framework enabled a dialogue between staff and the research team which identified that staff and students held differing opinions as to the meaning of spatial awareness as it related to the course. Further, the staff felt that spatial awareness was not a threshold concept, but did pinpoint several potential concepts that may comprise spatial awareness. Using these, a pilot measurement tool was developed (TPD Test) which was implemented alongside the existing Purdue Visualization of Rotations Test (PVRT) with first year students on the 2006 intake. The results of the tests indicate that although they did measure students' spatial awareness skills on entry to the course, there was no correlation between these and the students' end of the year assessment results. Therefore, it is posited that the tests are not a suitable method for determining pedagogical interventions for students and that spatial awareness development is not a threshold concept, or the creative baseline of the course, *for the first year of study*.

Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

References

Bodner, G. M. & Guay, R. B. (1997) The Purdue Visualization of Rotations Test. *The Chemical Educator,* 2, 1 - 17.

Buchanan, R. (1992) 'Wicked Problems in Design Thinking.' in *Design Issues*. Spring. V8 No2

Clouder, L. (2005) Caring as a 'threshold concept': Transforming students in higher education into health (care) professionals. *Teaching in Higher Education*, 10, 505-517.

Cousin, G. (2006) 'Threshold concepts, troublesome knowledge and emotional capital: an exploration into learning about others.' In Meyer, J.H.F. and Land, R. (eds) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge.* London and New York: Routledge. pp134-147

Craddick, M. & O'reilly, D. (2002) 'Structures for facilitating play and creativity in learning: a psychoanalytical perspective.' In Wisdom, J. (Ed.) *Academic and Educational Development: Research, Evaluation and Changing Practice in Higher Education.* London, Kogan Page.

Davies, P., and Mangan, J. (2007) 'Embedding Threshold Concepts: from Theory to Pedagogical Principles to Learning Activities.' In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam.

Eliot, J. (2002) About spatial intelligence: I.' *Perceptual and Motor Skills*, 94, 2, 479-186.

ELTQ (2002) ETL Project, Universities of Edinburgh, Durham and Coventry. Available at http://www.tla.ed.ac.uk/etl/project.html

Gardner, H. (1983) *Frames of Mind: the theory of multiple intelligences*. New York, Basic Books.

Garg, A., Norman, G., Spero, L. & Taylor, L. (1999) 'Learning anatomy: do new computer models improve spatial understanding?' *Medical Teacher*, 21.

Ho, R. (2006) Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS, Boca Raton, Fl, Chapman and Hall.

Karnath, H.-O., Ferber, S. & Himmelbach, M. (2001) 'Spatial awareness is a function of the temporal not the posterior parietal lobe.' *Nature*, 411(6840), 950-3.

Lucas, U. & Mladenovic, R. (2006) 'Dissolving the boundary between research and teaching: exploring threshold concepts within introductory accounting.' *Beyond Boundaries: New Horizons for Research into Higher Education*. Brighton, SRHE.

Meyer, J. H. F. & Land, R. (2003) 'Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines.' In Rust, C. (Ed.) *10th International Symposium on Improving Student Learning: Theory and Practice - 10 years on.* Oxford, Oxford Centre for Staff and Learning Development.

Osmond, J. & Bull, K. (2007) 'Can creativity be taught: Creativity in Transport and Product Design' *ELIA Teachers' Academy*. Brighton. available at http://www.elia-artschools.org/activities/programme_ta.xml (strand A2)

Osmond, J., Turner, A. & Land, R. (2007) 'Threshold Concepts and Spatial Awareness in Transport and Product Design.' In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam.

Perkins, D. (1999) The many faces of constructivism. *Educational Leadership,* 57, n3 p6-11.

Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

Perkins, D,. (2000) *The Eureka Affect: The Art and Logic of Breakthrough Thinking*. W.W. Norton & Co. New York. London.

Perkins, D. (2001) Breakthrough thinking and the Eureka Effect: An interview with Professor David Perkins. Harvard Graduate School of Education. 1st December 2001. Available from http://www.gse.harvard.edu/news/features/perkins12012001.html

Shearer, B. (2004) 'Multiple intelligences theory after 20 years.' *Teachers College Record*, 106, 2-16.

Wenger, E. (1998) *Communities of practice :learning, meaning, and identity.* Cambridge, Cambridge University Press.

Osmond, J., Turner, A. (2008) 'Measuring the creative baseline in transport design education.' In Rust, C. (ed) *Improving Student Learning - For What*? OCSLD. Oxford.

Submission [3]

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2.1
Research, Learning and Teaching

2.1.2
‘Stuck in the Bubble’: Identifying Threshold Concepts in Design

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Abstract

This paper briefly details the journey to date that the Centre of Excellence for Automotive and Product Design (CEPAD) at Coventry University has taken toward identifying threshold concepts in design, one of three research strands outlined in the original 2005 CETL bid document. The research allowed the emergence of tacit assumptions and knowledge of the discipline and details how a threshold concept for first year design students was identified. The paper then proposes two questions for discussion arising from the work with the aim of exploring the possible impact on the higher education art and design community.

Introduction

This paper briefly details the journey to date that the Centre of Excellence for Automotive and Product Design (CEPAD) has taken toward identifying threshold concepts in design (Osmond *et al.*, 2007, 2008, 2009), one of three research strands outlined in the original 2005 project bid document. The paper then proposes three questions for discussion, which have arisen from the work, with the aim of exploring the possible impact on the higher education art and design community.

The journey

The journey began with a consideration of possible threshold concepts for the first year of study for the transport and product design course at Coventry University, with threshold concepts being defined by Meyer and Land (2003) as concepts that:

> *...represent a transformed way of understanding, interpreting or viewing something without which the learner cannot progress.* (p.1)

As transport and product design staff felt that the successful development of spatial awareness skills was crucial if students were to gain entry into the design community of practice, a research question was formulated to examine if spatial awareness was a threshold concept. First year students and their tutors were interviewed in order to define the term 'spatial awareness' as it applies to the transport and product design course, and also identify other potential threshold concepts. In relation to the meaning of spatial awareness, the data yielded a multiplicity of meanings from staff, and little knowledge from students. However, several potential threshold concepts were identified, the more practical of which were incorporated into the development of a pilot spatial awareness measurement tool, which, it was hoped, could be used to assess students' suitability for the course at application interview.

The pilot measurement tool was implemented with a first year cohort of 114 students alongside *The Purdue Visualisation of Rotations Test* (Bodner and Guay, 1997), the latter being a recognised tool for measuring spatial awareness. The results of both tests were compared with students' end-of-year assessment results and no correlation was found. Therefore, despite the emphasis by staff on the importance of students' spatial awareness development, there appeared to be no common definition available and end-of-year assessments did not specifically measure it. The research team concluded from this that spatial awareness was not a threshold concept, at least for the first year of study.

However, a potential threshold concept did emerge from the data, tentatively identified by staff as the 'confidence challenge' and defined as the ability to inculcate design conventions and expand upon them using information from a variety of sources and experiences.

This confidence enables students to tackle what Buchanan (1992) describes as 'wicked' problems, which:

> *...have incomplete, contradictory, and changing requirements; and solutions to them are often difficult to recognize as such because of complex interdependencies.* (p.6)

Further investigation into the 'confidence to challenge' was undertaken during the third and fourth year of the CETL project and revealed that the actual threshold concept is the process that *leads* to the confidence to challenge. Tentatively labelled the 'toleration of design uncertainty' it is defined as:

> *…the moment when a student recognises that the uncertainty present when approaching a design brief is an* essential*, but at the same time* routine*, part of the design process.*

Both the design (Cross, 1992; Dorst, 2003, 2008) and the creativity literature (Kleiman, 2008; De-Bono, 1995; Baillie, 2003; Amabile, 1983 in Vidal, 2009) recognise this moment, and at its simplest it can be understood as the process before a 'eureka' moment, which Tovey (1984) describes as an 'incubation' period:

> *It is possible that the incubation periods, that time of apparent inactivity during which the designer's brain furiously grapples with the problem, is simply the period during which the two halves of the brain are out of touch or unable to agree. By contrast, the moment when they do suddenly come into alignment would be the classic 'eureka' point'.* (1984: 226)

Further, Wallace (1992) describes it as 'problem bubbles':

> *Progress through many simultaneous tasks involves solving hundreds of individual problems… To solve a particular design task, the complete set of problem bubbles associated with the task must be solved; but many, many bubbles not directly related to the task will be entered between starting and finishing the task…* (p.81)

Therefore, some students may get stuck in Wallace's problem bubble when searching for design inspiration, and this is reflected by this student quote:

> *I think during the very beginning I really struggled to really know what I should do in my projects – you really spend a lot of time to think about it but the result is not really that good as you expected because you keep surfacing around, you can't really make decisions about doing … that's one of the most negative feelings because you don't know what to do sometimes – I mean I understand you do projects … it is not really satisfying teachers, you learn during the process, but still you want to know what they really want.*

As reported in Osmond and Turner (2009), the toleration of uncertainty fits Meyer and Land's (2003) definition of a threshold concept as *transformative* in that the students accept that this is what a designer 'does' and thus they begin their journey to the designer identity. It is *irreversible* in that they would find it very difficult to 'un-think' themselves from a design identity, and *integrative* in that they realise that everything they know, learn and experience is a legitimate source of inspiration (for example, accepting that those moments when they dance around the bubble thinking about subjects that are not directly related to their task may turn out to be the most important part of the process). And, most of all, it is *troublesome* in that the students will constantly experience and re-experience the 'surfacing around' as they hunt for a solution, even when they attain the status of professional designer.

Therefore, it is argued that the toleration of design uncertainty is a transformative moment for design students: without this transformation, students can remain in a liminal state, described as:

> *an in-between state of uncertainty and insecurity in which they do not enjoy full community membership status and struggle both to make sense of the underlying episteme and also to find their own creative identities as design practitioners.* (Osmond, *et al*., 2007)

The most recent data to emerge from the study indicates that passing through the toleration of design uncertainty may or may not take place for some students before they enter university, and could

Accepting that those moments when they dance around the bubble thinking about subjects that are not directly related to their task may turn out to be the most important part of the process.

therefore be related to the kind of creative educational background they have previously experienced. It is possible then that students who arrive at university having *not* passed through this threshold and who also face large class sizes and the concomitant staff:student ratio may remain in Wallace's problem bubble far longer than is necessary. In addition, this may pose even greater difficulty for those international students who are used to a more prescribed curriculum that privileges a 'rote' style of learning rather than a 'creative' style.

These findings have obvious implications for course design and deserve further investigation. Further investigation is also indicated into how applicable this threshold concept is to other creative disciplines. To date, interest has been shown by the art and design sector and measures are underway to locate appropriate sources of funding.

Conclusion

The research into threshold concepts in design at Coventry University has highlighted that as a research framework it is capable of surfacing – often tacit – assumptions and knowledge that form the *episteme* of a discipline, which Perkins (2006) defines as:

> *a system of ideas or way of understanding that allows us to establish knowledge.* (p.42)

In this case, the research identified that spatial awareness development, although of critical importance in terms of the development of designers, was not actually the critical element during the first year of study. Further, the research framework allowed the examination of several other pieces of tacit knowledge, in particular 'the confidence to challenge', which again did not prove to be a threshold concept, but did allow the researchers to identify the process leading up to it: 'the toleration of design uncertainty'. The identification of this threshold concept was then underpinned by its presence in the staff and student data and in the design and creativity literature. More recently, data has indicated that students' ability to pass through this threshold may be linked to their previous creative educational background.

Therefore, using the threshold concept research framework has enabled the surfacing of the episteme that is characteristic of a discipline, and this knowledge can now be used as a baseline for further investigations. In this case, it is hoped that this will be a focus on the examination of students' previous educational backgrounds and potential applicability to other creative disciplines.

Questions

1. The threshold concept has been identified as peculiar to the transport and product design course at Coventry University. However, the recognition of, for want of a better phrase, the 'eureka' moment, in the design and creativity literature, points to the possibility that the threshold concept may well exist in other creative disciplines. Therefore, should we – and if so, how do we – examine this possibility across other creative disciplines, such as music, dance and fashion to name but a few?
2. If every design student does face design uncertainty at some point in their design education, and does not achieve toleration of design uncertainty before they get to university, it could be argued that the increased number of students on design courses and concomitant staff:student ratios may mean that they do not get the appropriate support and 'safe' space that allows them to experience this transformative moment. Therefore, should we, as educators in creative disciplines, be:

    - Recognising that established teaching and learning styles are often predicated on class sizes that were historically much smaller, and students who were perhaps better 'university-trained'?
    - Researching and identifying what type of creative educational background is the most successful in preparing students for the toleration of design uncertainty?
    - Redesigning courses that privilege the threshold concept and thus take into account the lack of appropriate creative background in both home and international students?

References

Baillie, C. (ed.) (2003) *The Travelling CASE: Fostering Creative Thinking in Higher Education*. UK Centre for Materials Education. Learning and Teaching Support Network.

Bodner, G. and Guay, R. (1997) The Purdue Visualisation of Rotations Test, *The Chemical Educator*, 2(4): 1-17.

Buchanan, R. (1992) Wicked problems in design thinking, *Design Issues*, 8(2).

Cross, N. (1992) Research in design thinking, in N. Cross, K. Dorst and N. Roozenburg, (eds) *Research In Design Thinking*. Delft: Delft University Press.

DeBono, E. (1995) Exploring patterns of thought: serious creativity, *Journal for Quality and Participation*, 18(5): 12-18.

Dorst, K. (2003) *Understanding Design: 150 Reflections on Being a Designer*. Amsterdam: BIS.

Dorst, K. (2008) Design research: a revolution-waiting-to-happen, *Design Studies*, 29(1): 4-11.

Kleiman, P. (2008) Towards transformation: conceptions of creativity in higher education, *Innovations in Education and Teaching International*, 45(3): 209-217.

Meyer, J.H.F. and Land, R. (2003). Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines, in C. Rust, (ed.) *Improving Student Learning. Improving Student Learning Theory and Practice – 10 Years on*, pp.412-424. Oxford: OCSLD.

Osmond, J. and Turner, A. (2008) Measuring the creative baseline in transport design education, in C. Rust, (ed.) *Improving Student Learning – For What?* Oxford: OCSLD.

Osmond, J. and Turner, A. (2009) *The Threshold Concept Journey: from Identification to Application. Threshold Concepts: From Theory to Practice*. Rotterdam: Sense Publishers (in press).

Osmond, J., Turner, A. and Land, R. (2007) Threshold concepts and spatial awareness in automotive design, in R. Land and J.H.F. Meyer, (eds) *Threshold Concepts Within the Disciplines*. Rotterdam: Sense Publishers.

Perkins, D. (2006) Constructivism and troublesome knowledge, in J.H.F. Meyer and R. Land, (eds) *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge*, pp. 33-47. London and New York: Routledge.

Tovey, M. (1984) Designing with both halves of the brain, *Design Studies*, 5(4): 219-228.

Vidal, R.V.V. (2009) Creativity for problem solvers, *AI and Society*, 23: 409-432.

Wallace, K. (1992) Some observations on design thinking in N. Cross, K. Dorst and N. Roozenburg, (eds) *Research in Design Thinking*. Delft: Delft University Press.

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JANE OSMOND AND ANDREW TURNER

21. THE THRESHOLD CONCEPT JOURNEY IN DESIGN:

From Identity to Application

INTRODUCTION

This chapter builds upon previous research (Osmond and Turner 2008) outlined in Land and Meyer's Threshold Concepts within the Disciplines published in 2008. Specifically, it outlines the use of threshold concepts as a research framework within the transport and product design course at Coventry University, and then considers the journey from seeking to identify a threshold concept to a consideration of its potential impact on teaching and learning.

BACKGROUND

The research began in 2005 within the Centre of Excellence for Product and Automotive Design (CEPAD), established from a successful bid to the Higher Education Funding Council for England (HEFCE), as part of the CETL initiative. Pedagogical research has been a key activity within CEPAD with three inter-related strands of enquiry: identifying threshold concepts in design, examining the development of spatial awareness and investigating the internationalisation of the design curriculum. This chapter focuses on the research relating to the identification of threshold concepts in design.

As previously reported by Osmond and Turner (2007), at the outset of the research it was soon evident that in relation to pedagogical theory, the Transport and Product Design discipline was relatively untheorised, and approaches to teaching used by the Transport and Product Design staff were underpinned by a 'tacit underlying agenda of things that students need to have' (IBID). A similar observation by Buchanan in relation to design research is that within the design community there has been relatively little consideration of the nature of design research and its value, and questions about whether there is 'design knowledge that merits serious attention.' (1999: 3). This is echoed by Dorst (2008), who argues that most research into design has focused on the *process* of design at the expense of the development of the designer, and Rogers: 'In this respect, design research is a relatively young discipline and does not possess a well established knowledge base when we compare it to the likes of the sciences, humanities and other more established scholarly disciplines [4].

J.H.F. Meyer, R Land and C Baillie (eds.). Threshold Concepts and Transformational Learning. 347-363.

Further, a pilot study using an existing research methodology (ELTQ 2002) based on phenomenographic research was found to have little relevance to this context. The pilot used the Experiences of Teaching and Learning Questionnaire (ELTQ 2002), developed from the ESRC-TLRP project "Enhancing Teaching-Learning Environments in Undergraduate Courses", but notions of deep and surface learning were found not to be particularly applicable to the course, with the questionnaire itself found to be both too atomistic and generic a tool. Similarly, the notions and characteristics of deep and surface learning had little resonance with staff and students in relation to the nature of learning or student engagement, perhaps reflecting the increasing debate around the notion of deep/surface learning exemplified by Beattie et al (1997) and Haggis (2003).

The research therefore focused on the notion of threshold concepts (Meyer and Land), which were introduced to characterise the idea that in certain disciplines there are concepts that:

> …represent a transformed way of understanding or interpreting, or viewing something without which the learner cannot progress. (2003)

Since the initial definition, the notion of threshold concepts has been further developed (Meyer and Land, 2005) and threshold concepts have been identified across disciplines as diverse as health, accounting, languages, communication studies and online spaces (Clouder, 2005; Lucas and Mladenovic, 2006; Orsini-Jones 2008, Cousin, 2006, Savin-Baden, 2008). The applicability and relevance of the notion of threshold concepts across disciplines is also reflected in an increasing body of literature and events focusing on threshold concepts both generally and within disciplines.

Within this context, the threshold concept framework was applied as a lens to research the Transport and Product Design Course in order to identify key concepts that students need to acquire in their development as designers and enable them to enter both national and international transport and product design industries. The concept provided a very useful starting point for opening up a research dialogue with both students and staff of the courses. Staff in particular engaged enthusiastically with the pedagogical research team in both interviews and whole-staff meetings and found the thresholds approach accessible in terms of a theoretical concept and the language (Osmond et al., 2007, 2007a). From the perspective of the pedagogical research team, threshold concepts provided a 'way in' to conducting pedagogical research with staff who may have had little or no engagement or knowledge of existing pedagogical research or theory.

Initially, to help identify potential threshold concepts in this area, and bearing in mind that staff saw possessing and developing spatial awareness as a crucial aspect of the student journey, a research question was posed: 'Is spatial awareness a threshold concept for the Transport and Product Design course?'. A concomitant research aim was to develop a discipline specific tool to measure the student journey in terms of spatial awareness from entry to the end of the first year.

Interviews with staff were carried out using the above research question as a baseline and a key finding was that there was no common definition of the meaning of spatial awareness as it related to the Transport and Product Design course.

Staff responses ranged from 'all round awareness' to 'design sensitivity'. In addition, student responses were gathered through a mixture of qualitative interviews and questionnaires and these responses were categorised as 'having no knowledge', 'little knowledge' and 'guessing' (see Table 1 below).

Table 1: Staff and student perceptions of the term 'spatial awareness' (Osmond et al. 2007)

Category	*Indicative response: staff*
All around awareness	I don't think there is any area of conscious thought about anything that the design business doesn't touch on in a way that few others do: it is this business of this incredible all-round awareness.
	Holistic approach: cloud of information with polarised areas.
Co-ordination	Hand/eye/brain co-ordination.
Design sensitivity	Sensitivity: being able to 'see' design; some see it as a picture, others see it as presenting and manipulating information.
	Seeing things as a whole, but having an instinct to knowing which bit to highlight to achieve certain purposes.
Space	Displacement of space.
	'Relationship between form and spaces.'
'Intuitive/6th sense.'	Intuitive/6th sense.
Looking at an object from the outside	I think it really has to be looking at an object.
	Awareness of an object at a distance.
Mental rotation	2D to 3D translation.
	Looking at an object at a distance, but able to perceive it in the round in detail.
Positioning system	Spatial positioning system working on several planes.
	Is about navigation and urban environments.
Time	Relates to time especially when orienting through large spaces.
Visualisation	Somebody being able to sit in a chair and visualise what the space around them is and look at that on drawings and have a concept of what that means.
	Understand what that means in terms of space around a product, car, phone...
Volume	Relates to the ability to transform volume.
Category	*Indicative response: students*
No knowledge	I can't say I do. I would like to guess but I might be wrong.
	Never heard of it before.
Some knowledge	No, I have heard the term but I am not aware of it.
	I've heard of it before…
	Like distance from things and if something will fit into a certain space or if it doesn't?
	In what sense – when you walk into a room and feel a lot of space?

However, although no common definition of spatial awareness was reached, a number of possible threshold concepts did emerge from the data, some of which were used to inform the development of a pilot spatial awareness measurement tool (©TPD Test) which was implemented with 114 first-year students alongside an existing spatial awareness test (PVRT), the latter specifically designed as the basis for evaluating courses developed to enhance students' spatial skills. (Figure1)

Analysis of the PVRT test results were undertaken and the mean score was comparable to previously published scores for this test carried out by Purdue University; in addition the TPD Test results correlated with the PVRT results indicating that the tests were assessing similar aspects of spatial awareness. The results were then compared with students' end of year assessment results, with a specific comparison undertaken with a 2D and 3D representational module, but no correlation was found. In other words, scoring well or not so well in both tests did not correlate with how the students performed in their assessment results, and therefore whether they passed their first year of study.

Due to the lack of common definition of spatial awareness amongst staff and students and the lack of correlation between the tests and end of year assessment results, the research team concluded that spatial awareness, as represented in the tests, was not a threshold concept in the first year of study. This lead to a reconsideration of the meanings inherent in the term 'spatial awareness' and how

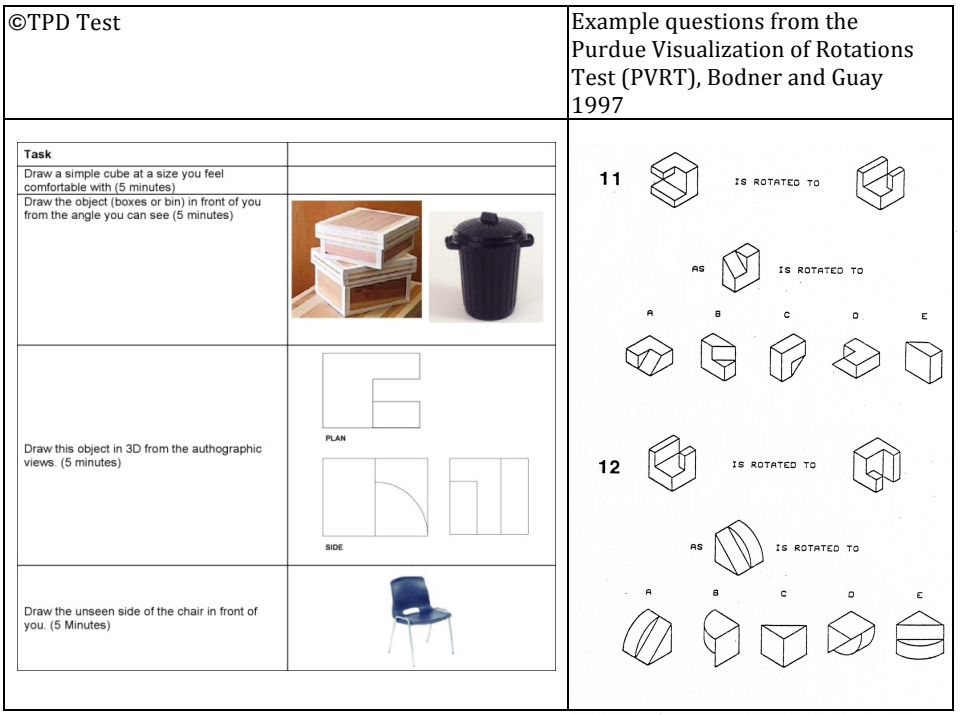

Figure 1: TPD Test (Osmond 2007) and existing spatial awareness test

relevant it was to the Transport and Product Design course. Current work focusing on the term 'visual creativity' is currently under investigation. Meanwhile, whilst spatial awareness was not seen as a threshold concept, a number of possible threshold concepts did emerge, with the notion of 'confidence to challenge' tentatively identified as a threshold concept within the first year of the course. (see Osmond et al. 2007a)

DEFINING THE THRESHOLD CONCEPT

As described above, the research tentatively identified 'confidence to challenge' as a first year threshold concept, defined by an Industrial Design tutor as:

> the ability to inculcate design conventions and expand upon them using information from a variety of sources and experiences.

This 'confidence to challenge' allows students to tackle what Buchanan calls 'wicked problems', which

> ...have incomplete, contradictory, and changing requirements; and solutions to them are often difficult to recognize as such because of complex interdependencies.' (1992)

Without this confidence students can remain in a liminal state, constantly 'surfacing around' in search of a solution, and this seemed to present even more difficulties to those international students who are used to a more prescribed style of teaching and curriculum:

> I think during the very beginning I really struggled to really know what I should do in my projects - you really spend a lot of time to think about it but the result is not really that good as you expected because you keep surfacing around, you can't really make decisions about doing … that's one of the most negative feelings because you don't know what to do sometimes - I mean I understand you do projects it is not really satisfying teachers, you learn during the process, but still you want to know what they really want. (first year international student)

A search of the design literature reveals that the 'surfacing around' described by the student quote above, chimes with Tovey's (1984) notion of an 'incubation period' that designers tend to experience:

> It is possible that the incubation periods, that time of apparent inactivity during which the designer's brain furiously grapples with the problem, is simply the period during which the two halves of the brain are out of touch or unable to agree. But contrast the moment when they do suddenly come into alignment would be the classic 'eureka' point.' (226)

This is also described by Cross as the attention of the designer oscillating between the problem and the solution, epitomised by this quote from Archer (1979):

> The design activity is commutative, the designer's attention oscillating between the emerging requirement ideas and the developing provision ideas,

> as he illuminates obscurity on both sides and reduces misfit between them.' (quoted in Cross 1992: 5)

Whereas Dorst likens this uncertainty to 'tightrope walking' in that designers can work on a design for indefinable lengths of time, not knowing whether the design will be successful or reach a 'satisfying conclusion.' (2003:97).

This incubation period can also be likened to Wallace's concept of a 'bubble' (Figure 2), which he describes as:

> Progress through many simultaneous tasks involves solving hundreds of individual problems...To solve a particular design task, the complete set of problem bubbles associated with the task must be solved; but many, many bubbles not directly related to the task will be entered between starting and finishing the task...' (1992:81)

Wallace therefore marks out the terrain a designer routinely enters when first approaching a design, which one member of staff described as 'the explosion in the head which actually makes them better designers', and is a sentiment echoed by Cross when he states that a good designer '...is someone who has no limitations in having odd and strange ideas in that early stage of the concept phase.' (IBID:13)

Further, Dorst and Lawson's (2008) 'Levels of Design Expertise' model (based on a model originally developed by Drefus) and outlines six levels of expertise in relation to a designer's development. A fledgling designer will begin in the 'naive'

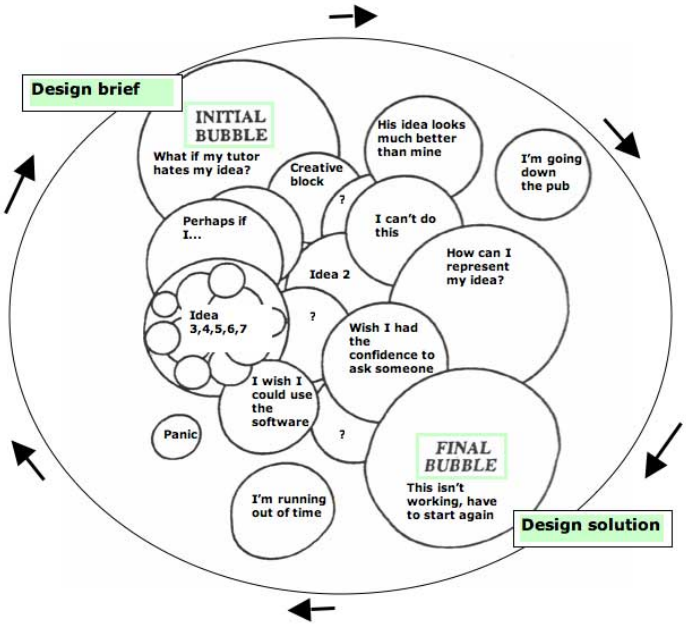

Figure 2: Stuck in the Bubble (adapted from Wallace 1992)

category, where the student has not yet realised that 'design is a series of activities'. The student then moves to the 'novice' category where rule-based design is the norm. The next stage is to 'advanced beginner' which involves situation-based design, followed by the 'competent' design stage where the focus is on strategy-based design. The student then moves into the expert category where pattern based design is used, and finally to the 'visionary' category where designers incorporate all the previous categories and strive 'to extend the domain in which they work...new ways things could be, defines the issues, opens new worlds and creates new domains.' (2008:9). Therefore, it appears that the students can be characterised as being as the 'naïve' stage, where they do not yet realise that 'design is a series of activities' and the surfacing around and/or incubation period experience is perhaps the initial stage on the journey to becoming a 'visionary' designer.

The period of uncertainty or being 'stuck in the bubble' when looking for solutions and considering alternatives for solutions has also been identified as an important part of the process of the 'creative thinking' process. Although the terms and context vary, the principle and importance of a period of uncertainty is well recognised. For example, Kleinman talks about 'Creativity-as-process':

> Creativity-as-process is conceptualised [and] conceived as leading to implicit or intangible outcomes and...as not linked to any outcome. While the latter may appear illogical, in that all processes must lead to some form of outcome, and seems perhaps counter-intuitive, it recognises that creativity sometimes requires an acceptance of a lack of structure and direction, e.g. 'playing for the sake of playing'. (2008)

DeBono (1995) in describing his six 'thinking hats' system refers to the importance of creating time and space for creative thinking. The coloured hats are used as a tool to allow time and space for creativity, with the different coloured hats denoting a particular type of thinking. There is no set order to 'wearing' the hats but ideas such as thinking for 'ideas and proposals' and 'evaluating the alternatives' clearly resonate with the ideas of 'surfacing around' for solutions identified in this research. In addition, DeBono identifies 'provocations' to achieve 'movement' to come up with new solutions, defining movement as a mental operation requiring 'confidence and practice'. Amabile (1983 *in* Vidal 2009) in defining the creative person describes how 'creative thinking skills determine how flexibly and imaginatively people approach problems and tasks. It demands courage to be creative because you will be changing the status quo', and Baille (2003) focuses on fostering students' creative thinking skills in particular through a series of case studies entitled *The Travelling Case*. Other publications that identify the importance of creativity in problem solving include Vidal (2009); Kotzé & Purgathofer (2007) and Dekker (1995).

It is likely then that some first year students, when faced with a design brief for the first time, can get 'stuck' in Wallace's bubble, perhaps lacking 'the ability to entertain ambiguity and complexity' (Wylant 2008), and subsequently may panic as they search for solutions. In practice then, they may be afraid of admitting that they don't understand the brief or can't get past a creative block and constantly

enter and re-enter the bubble as they struggle for inspiration, and, at this stage, lack the 'confidence to challenge'.

INVESTIGATING THE THRESHOLD CONCEPT

The notion of 'confidence to challenge' as a threshold concept was explored further during the third year of this research through a whole-staff meeting and one-to-one interviews with five third year students (including one international student) who were originally interviewed as first year students.

The aim was to establish evidence of progression through the threshold concept, perhaps identifying critical points (such as key experiences and assessments) which enabled this and to this end each student was presented with a picture of a piece of assessed first year work and asked to describe how they would approach such a brief from their 3rd year perspective. Two students were quite taken aback to be presented with a piece of work that they hadn't seen for over two years:

> Hmm, 40% didn't do very well, I don't think I read the brief properly - I think that was what - my drawing skills don't look fantastic either.

> I look at my first year work now and I think I shouldn't really be here. Yeah, at the time I knew for example some of the things could have been better, but compared to what I can do it is like I am looking at myself 10 years ago thinking what were you doing - quite shocking.

They all recognised that there was a real difference in how they would approach the same brief and talked about how they felt they had progressed quite significantly since their first year, typified by this comment from one of the students:

> I can approach things in a more homogenous way...a holistic approach now. I can actually look at things and think well it looks good - works well. First year I felt like I approached things from separate angles and hoped that they would collide in the middle and I would have something that looked good and worked well, but now I find that I can merge things together while I am doing it, it is more controlled.

Interestingly, three students felt that their actual thought process had not changed since the first year, rather, that they had been given the tools to underpin and express the process in improved designs:

> ...it is kind of an emotional/emotive thing that goes on in your head - as you progress along the year, you do learn new skills and new ways of handling/tackling a project or handling different stages, but in the thought processes - I would say that the actual rigid structure of thinking in the way to tackle the project hasn't changed that much...you just improve on what you have got, rather than a total overhaul of your thinking processes

> I still think my thought processes are quite similar to the way I used to think compared to the way I used to think in the first year or second year
>
> I think there is a natural thought process that you actually do compose as the project goes along

However, the students did confirm that the sense of being stuck in the bubble when faced with a new brief was still present in their third year:

> It has happened to all of us at one point or another, when you have had that soul crushing moment when you think I can't do it or something has gone wrong and you haven't got time.
>
> Oh yes there are still some briefs that you do have to rack your brain over and think what is going on here

This difference between the first and third year appeared to be that the students had inculcated and used coping strategies:

> If [it] happens in the 1st year I don't think you would be equipped to deal with it, but in the 2nd and 3rd you have learnt the skills to get round that problem.
>
> I have actually found that I am quite good at pressing the reset button and getting everything back together.
>
> I think actually understanding of the briefs you really need to know what you are talking about and be able to understand it right from the beginning and make sure your understanding of it is the right one - because if you think you completely understand and it comes to the end of the assessment, and yeah but I understood the brief, they are like no you didn't understand it in the correct way so you have to make sure you understand right from the very beginning- I think that is definitely something that I need to make sure is happening,

It seems then that by their third year of study, the students were still getting stuck in the bubble, but had developed strategies to deal with it by accepting that this is part of the design process:

> Pressure - you are up against the wire and you have got a few hours left and you think to yourself...what am I going to do? It is that pressure that forces you to condense your skills into something useful - I feel that's when I have learnt most - when I have been up against the wire.

The result is an increased confidence in not only drawing on different strategies to cope, but also translates to presenting and defending their actual design work. All the students mentioned that the work they carried out as part of a group in their third year, aided by an assignment that required them to present designs to companies who agreed to pose as 'clients', boosted their confidence:

> Yes, I was able to stand in front of the editor of [...] today and wing the presentation when the video wasn't working and he really liked it. I felt that I can do that a lot more effectively now, you have the practice of defending everything you have done.

> To explain why you have done something and why you think it is good I feel that I have got a lot more confidence
>
> I think [my confidence] has definitely improved - I am still not 100%...the group work we were doing a lot of in the studio in front of everyone else - I had to be confident with my work and I was proud of it in the end, I would be drawing something and this doesn't look quite right and someone else would tell me if there was something wrong with it that they could see or they would say it was really good.

It appears then that during the first three years of the course, the students undergo a series of transitional moments that enhance their ability to progress through the bubble when faced with a design brief, which is underpinned by the development of an inquisitive attitude/hunger for knowledge; a 'playfulness' that facilitates the stretching of boundaries; a lateral and logical approach to tackling problems and an ability to evolve, change and refine ideas. Further, tutors feel that releasing students' creativity comes to the fore during the process of design; '...through problem solving, direct modelling, sketch modelling...experiencing it where it really takes place.' (Osmond and Bull 2007). Previous research (Osmond et al., 2007) observed that this facilitation of creativity is underpinned by the provision of a studio environment that favours a teaching approach akin to the atelier principal of teaching, defined by Craddick and O'Reilly (2002) as involving a group of students…working with one or two tutors…through a year-long cycle of design.' facilitated by a staff who cultivate a 'respect for the creative mind' (Design Tutor). In this, the teaching method resembles the apprenticeship model, in which effective teaching, according to Pratt is

> ...a process of socializing students into new behavioural norms and professional ways of working. Effective teachers are highly skilled practitioners of what they teach. Whether they are in classrooms or in clinical settings, effective teachers are recognized for their professional knowledge and expertise. (2005)

TRANSITION POINTS

For the first year students, one member of staff talked about how the result of the first assessment was an important transitional moment, almost like a reassurance that the students 'had the right' to be on the course:

> ...something about having gone through the process and being reassured...[they feel] am I still here? Can I stay? Now can I actually call myself a designer?

With second year students a seminal moment occurs when the students use clay for the first time. This experience brings a number of concepts together, in particular, space - physically in terms of the actual studio environment, and conceptually, in terms of the brief which requires them to produce a 'clay head' based on their imagination (Figure 3), and an awareness of each other as a.group:

Figure 3: Clay heads project

> Somewhere towards the end of the 5-week clay head part – their own studio, freedom they are given – and their understanding all of a sudden of who they are in the group and working together in a sustained way, and achieving.

Just after the experience with the clay heads, the staff mentioned an increase in confidence in terms of students approaching them:

> Another gateway is just after the clays, because I tend never to see any students come to tutorials until they are in year 2 and then we do the empowering 'yes you can go and do this'.

> Being mature enough to turn up and talk to us...We are perhaps changing their view from us being teachers to just people, to facilitators

A transition for third year students was mentioned in reference to being exposed to the 'world of work' either through a company placement or an in-house design placement:

> Going out on a real placement or a placement alternative here, where you do need to get up for work and behave in a professional way - when they finish that, there is definite change from then on.

Another change noticed by staff is how the students use technology differently during their third year:

> [in their second year, the students] get locked behind what is technically feasible, whereas we want the technology to enable their design rather than solve all the technology first - 2nd years seem to get locked behind that, whereas the third years don't.

Other transitional moments discussed by staff as spanning the students' journey through the course were group work and empathy. For the former, the key moment was when individual students realised that they had concede that their design was perhaps not the design that should be pursued:

> One of the big ones is working in groups – if their personal piece of work isn't the bit that gets chosen – a big one is to recognise is 'that idea is better than mine and I have to stop making that one work, and try and make this one work'.

For the latter - empathy - this relates to students having to expand their awareness to include the needs of other people, a particularly important transition for a designer:

> ...because what the students have to be able to do as a designer is not think like themselves, not got to design for themselves – and I think that is one of the most difficult - it is actually taking them out of themselves, and making them think like a 60 year old or like a child. I think that is one of the important breakthrough moments, when they stop doing that, when they stop thinking like a petrol-head. When they can think like an old lady trying get a bag onto a bus I think that is the breakthrough moment when they can achieve interesting design because it is that ability to think outside [of themselves]

The pedagogical design of the transport and product design course appears to be key in providing opportunities and experiences for key transitions in the student identity to occur and for the development of key design competencies. By the third year of study students are able to use learned competencies to negotiate the bubble - for example, knowing where to look for inspiration, tolerating a creative block until inspiration strikes, possessing relevant technological competencies, knowing how to use clay and not being afraid to approach peers and teachers for help. This progression is evidenced by the students' increased confidence in their own ideas and proposals, an example of which was discussed earlier when a third year brief involved the students presenting their ideas and proposals to real clients.

THE THRESHOLD CONCEPT

The key aspect identified in this research is the need for students to accept as an important and necessary part of design process, that period of uncertainty when they are searching and trying out different solutions or 'surfacing around'. We are therefore arguing that toleration of being stuck in the bubble - or Meyer and Land's liminal space - leads to the 'confidence to challenge', defined as inculcating design conventions and expanding upon them using information from a variety of sources and experiences. In other words, although the 'confidence to challenge' was originally identified as the threshold concept within this context, it is the *process*– the toleration of uncertainty - that brings about the transformation in the student, and this achievement of tolerance is linked to an increasing confidence in their own capability and identity as a designer to identify and propose design solutions. Using Meyer and Land's characteristics of threshold concepts, achieving toleration of being stuck in the bubble is *transformative* in that the students accept that this is what a designer 'does' and thus they begin their journey to the designer identity. It is *irreversible* in that they would find it very difficult to 'un-think' themselves from a design identity. It is *integrative* in that that they realise that everything they know, learn and experience is a legitimate source of inspiration (for example accepting that those moments when they dance around the bubble thinking about subjects that are not directly related to their task may turn out to be the most important part of the process). And, most of all it is *troublesome* in that the students

will constantly experience and re-experience the 'surfacing around' as they hunt for a solution, even when they attain the status of professional designer.

In other words, when students accept that part of the creative process is being stuck in the bubble - or they accept *the toleration of uncertainty* - while they search for inspiration, then they have achieved the confidence to play with both conventional ideas and challenge these with new thoughts, or perhaps develop the capability for what Perkins (2000) describes as 'breakthrough thinking' which leads to the 'kind of creativity that involves thinking outside the box.', or even 'thinking in a very different box.' (Wylant 2008).

IMPLICATIONS FOR TEACHING AND LEARNING

According to Davies and Mangan (2007) it is not enough to identify a threshold concept - for this activity to be useful, consideration of how this can affect the design of teaching and learning must be the next step. A characteristic of the assessments and activities associated with the transitional moments where students appear to progress through the threshold concept, appear to be problem-based, experiential, related to work and 'real-world' design activities and often involve group work; in other words there is a focus on 'doing as learning'. This reflects the growing interest evident in the literature in curriculum design incorporating work-related learning, the use of serious games and simulations using immersive virtual worlds (e.g. Savin-Baden and Wilkie, 2006, Gauntlett, 2007)

In contrast, development of the toleration of uncertainty seems to be implicit – almost an underlying agenda - in the teaching and learning process and to help first year students, in particular international students, perhaps explicitly surfacing this may enable them to develop suitable coping strategies during their first year on the course. In other words, by legitimising the 'stuck in the bubble moment', it is possible that students may feel more comfortable in this moment at an earlier stage.

However, surfacing the underlying agenda in a creative discipline such as this one could be problematic and surfacing 'the stuck in the bubble' moment may not enhance students' creative abilities. The course as it stands is very successful, and some members of staff would argue this is precisely because of the freedom the students are given to experiment and 'play' during the design process and that 'the stuck in the bubble' moment, if described and explicitly surfaced, may hinder their progress, or as a member of staff comments:

> Can't write it in a document. Sometimes to write things down kills them – you finally isolate it and nail it down and write it down it looks trite and stupid – it's not worth the paper it is written on – you can say it in the heartfelt way – it's meaningful – probably works as a quote – but it wouldn't work in text...'

Dorst echoes this when he talks about how existing models of the 'design process' exclude everything else that is happening when designers are in design mode and that 'it takes only an afternoon to explain one of the design process models to a group of design students. But knowing that model doesn't make these students designers at all...' (2008: 5)

Conversely, Perkins argues that by not surfacing the underlying agenda, or what he calls the episteme:

> ...many students never get the hang of it, or only slowly, because the epistemes receive little direct attention. For [students], surfacing the game through analytic discussion and deliberative practice could make a big difference. (2006: 43)

Wallace concurs when he states that design thinking is improved 'through being consciously aware of the design process' (1992:75) whilst at the same time 'hovering' above the bubbles.

Perhaps a way forward may well be to focus on the concept of negotiating the bubble as a way to assess gaps in student knowledge. If, in the first year, students were encouraged to articulate the reasons as to why they are stuck in the bubble - for example, 'I would like to produce a rotational 3D model on screen so I can play with it, but I don't know how to use the Alias software'; I can't seem to make this clay model work'; 'I am afraid of admitting that I don't understand the brief'; 'my mind is blank at the moment and I don't know how to get past it', then this feedback could facilitate appropriate interventions and support as well as legitimising their feelings of being unable to make a conceptual leap at this point in the course.

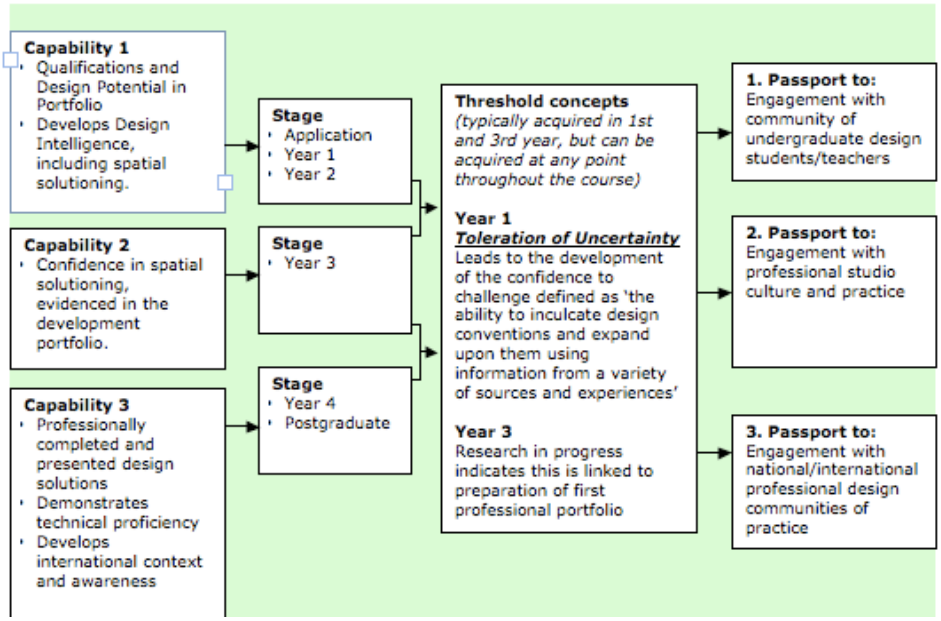

Figure 4: Representation model of threshold concepts in Transport and Product Design (work in progress)

At this point in the research, having identified a first year threshold concept, the intention is to explore the notion of introducing teaching and learning interventions along the lines of the discussion above. Further, research in progress indicates another threshold concept during the third year of the course which is linked to engagement with professional practice and the preparations of early professional portfolios. Finally, work is currently taking place on the development of a representational model of the research outcomes (see Figure 4 for early model development) which has the potential to be of use within the design disciplines and similar both within and outside Coventry University.

CONCLUSION

This paper has charted the identification of a threshold concept - the toleration of uncertainty. The research has also clearly identified nature and importance of the design of learning, teaching and assessment activities in facilitating the development of the identity of a designer- and has discussed some possible implications for teaching and learning for the transport and product design at Coventry University.

The researchers found that using threshold concepts enabled a useful and constructive dialogue with both staff and students within a relatively untheorised discipline. Although the research found that spatial awareness, considered as being at the heart of the course by staff was not a threshold concept but a design capability, it did allow the 'confidence to challenge' to emerge as a possible contender.

A search of design literature allowed the linking of the threshold concept to the work of Tovey's incubation period, Cross's oscillation between problem and solution, Dorst's tightrope walking, strategic thinking and visionary designer category; and, of particular interest, Wallace's idea of representing design tasks as a set of 'problem bubbles'. Links were also found in the creativity literature, particularly in the work of Kleiman, De-Bono, Baillie and Amabile.

We have argued that it is only when students have mastered toleration of a period of uncertainty that they gain the 'confidence to challenge' and are ready or able to tackle design briefs that typically contain 'wicked problems'. Further investigation of the 'confidence to challenge' with third year students showed that between entry and the third year of study they have developed a tolerance of being in a period of uncertainty due to inculcating skills, capabilities and coping strategies delivered via an apprentice-like immersive method of teaching underpinned by an atelier, or studio-based, environment. Staff also identified particular moments during the course that moved the students on, including first year assessments, the use of clay in the second year, exposure to the professional community of practice during the third year, coupled with the ability to work in groups and the development of empathy.

As such, the threshold concept has been identified as *the toleration of uncertainty* which precedes the development of the 'confidence to challenge' and it adheres to Meyer and Land's threshold concept characteristics in terms of being transformative, irreversible, integrative and, most of all, troublesome.

Implications for teaching and learning of the identification of the threshold concept are still a focus for research, but may include the introduction of teaching and learning interventions such as a first year module that surfaces the process to allow the identification of 'gaps' in the students' knowledge. Finally, the development of a model of the process is planned, as is further investigation into possible a third year threshold concept linked to students' exposure and engagement with the profession design community of practice.

REFERENCES

Baillie, C. (ed) (2003) The Travelling CASE: Fostering creative thinking in Higher Education. UK Centre for Materials Education. Learning and Teaching Support Network.

Bodner, G. M. & Guay, R. B. (1997) 'The Purdue Visualization of Rotations Test.' *The Chemical Educator*, 2, 1- 17

Buchanan, R. (1999) 'Design Research and the New Learning' in *Design Issues.* Volume 17, Number 4 Autumn 2001

Buchanan, R. (1992) 'Wicked Problems in Design Thinking.' in *Design Issues*. Spring. V8 No2

Beattie, V., Collins, W., McInnes, W. (1997) 'Deep and surface learning: a simple or simplistic dichotomy?' *Accounting Education* 6(1):pp. 1-12.

Clouder, L. (2005) 'Caring as a 'threshold concept. Transforming students in higher education into health (care) professionals'. *Teaching in Higher Education*, 10. 505-517.

Craddick, M. & O'reilly, D. (2002) 'Structures for facilitating play and creativity in learning: a psychoanalytical perspective.' In Wisdom, J. (Ed.) *Academic and Educational Development: Research, Evaluation and Changing Practice in Higher Education*. London, Kogan Page.

Cross, N. (1992) 'Research in Design Thinking' in Cross, N. Dorst, K, Roozenbury (eds) *Research in design thinking*. Delft University Press.

Cousin, G. (2006) 'Threshold concepts, troublesome knowledge and emotional capital: an exploration into learning about others.' In Meyer, J.H.F. and Land, R. (eds) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge. pp134-147

DeBono, E. (1995) Exploring patterns of thought: Serious Creativity *Journal for Quality and Participation* 18 (5) 12 - 18

Davies, P., and Mangan, J. (2007) 'Embedding Threshold Concepts: from Theory to Pedagogical Principles to Learning Activities.' In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam.

Dekker D.L.(1995) Engineering design processes, problem solving and creativity. In *Proceedings in Frontiers in Education Conference 1995, Atlanta, GA, USA,*

Dorst, K. (2008) 'Design research: a revolution-waiting-to-happen' in *Design Studies,* Volume 29, Issue 1. January. pp 4-11. Elsevier.

Dorst, K. (2003) Understanding Design 150 Reflections on Being a Designer. BIS. Amsterdam.

ETLQ (2002) ETL Project, Universities of Edinburgh, Durham and Coventry, Available at http://www.tla.ed.ac.uk/etl/project.html

Gauntlett, D. (2007) Creative Explorations: New approaches to identities and audiences, Routledge.

Haggis, T. (2003) 'Constructing Images of Ourselves? A Critical Investigation into 'Approaches to Learning' Research in Higher Education'. *British Educational Research Journal,* Vol. 29, No. 1, pp. 89-104.

Kleiman, P. (2008) 'Towards transformation: conceptions of creativity in higher education' *Innovations in Education and Teaching International*. Vol. 45, No. 3, 209–217

Kotzé, P., Purgathofer, P. (2007). A Framework for Design Exercises – From Creativity to Real World Use. In *HCI Educators 2007 - Creativity3: Experiencing to educate and design. 2007*. Aveiro, Portugal: GPCG, 59 – 68.

Land, R., and Meyer, JHF. (2007) (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam.

Lucas, U. & Mladenovic, R. (2006) 'Dissolving the boundary between research and teaching: exploring threshold concepts within introductory accounting.' *Beyond Boundaries: New Horizons for Research into Higher Education.* Brighton, SRHE.

Meyer, J.H.F. and Land, R. (2005) 'Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning'. *Higher Education,* Vol. 49, No. 3, pp. 373-388.

Meyer, J.H.F. and Land, R. (2003). 'Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines'. In C. Rust (Ed.), *Improving Student Learning. Improving Student Learning Theory and Practice — 10 years on*, OCSLD, Oxford, 412-424.

Orsini-Jones, M., Jones, D. (2008) 'Troublesome language knowledge 2: identifying 'threshold concepts' for students on a linguistics-based English degree course.' *From theory to practice conference.* Ontario. June

Osmond, J. & Bull, K. (2007) 'Can creativity be taught: Creativity in Transport and Product Design'. *ELIA Teachers' Academy*. Brighton. available at http://www.elia-artschools.org/activities/programme_ta.xml (strand A2)

Osmond, J., Turner, A., Land, R. (2007) 'Threshold Concepts and Spatial Awareness in Automotive Design' In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam.

Osmond, J., Turner, A. (2007a) 'Measuring the creative baseline in transport design education.' *Improving Student Learning Conference*. Dublin. September.

Perkins, D. (2006) 'Constructivism and Troublesome Knowledge', in Meyer, J.H.F. and Land R. (Eds.) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge. pp 33-47.

Perkins, D,. (2000) The Eureka Affect: The Art and Logic of Breakthrough Thinking. W.W. Norton & Co. New York. London.

Pratt, D. (2005). Five Perspectives on Teaching in Adult and Higher Education, Malabar, Florida: Krieger Publishing.

Savin-Baden, M. (2008) 'After the death of privacy: Liminal states and spatial identities' From theory to practice conference. Ontario. June

Savin-Baden, M and Wilkie, K. (2006) (Eds.) *Problem-based Learning Online*. Maidenhead: Open University Press/SRHE

Tovey, M. (1984) 'Designing with both halves of the brain' in *Design Studies*, Volume 5, Number 4. October. pp 219-228. Elsevier.

Vidal, R.V.V.(2009) Creativity for problem solvers, *AI and Society,* Volume 23 pp 409-432.

Wallace, K. (1992) 'Some Observations on Design Thinking' in Cross, N. Dorst, K, Roozenbury (eds) *Research in design thinking*. Delft University Press.

Wylant, B. (2008) 'Design Thinking and the Experience of Innovation. in *Design Studies*, Volume 24, Number 2. Spring. pp 3-14. Elsevier.

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Threshold concepts and the transport and product design curriculum: reports of research in progress

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Abstract
In 2005, Coventry University was successful in bidding for Centre of Excellence in Teaching and Learning (CETL) funding from HEFCE, which led to the creation of the Centre of Excellence for Product and Automotive Design (CEPAD).

This article discusses pedagogic research carried out by CEPAD to date, with a particular focus on the journey towards identifying one particular threshold concept in student transport and product design education. It also explores preliminary thoughts on how this identification of hitherto tacit knowledge can feed into the design thinking and solutioning process. From this, the article offers some implications for the enhancement of teaching and learning within the design curriculum.

Keywords
design curriculum threshold concepts industrial design tacit knowledge CETL
Pedagogic research

Introduction

In 2005, Coventry University was successful in bidding for CETL funding from HEFCE, which led to the creation of the Centre of Excellence for Product and Automotive Design (CEPAD). At its inception, CEPAD developed a qualitative research framework underpinned by a longitudinal study of a cohort of transport and product design students from entry to graduation. The aim was to investigate the development of transport and product design students' spatial awareness skills, enable the identification of thresh- old concepts in design, and enhance connection with the global community of designers through the internationalization of the design curriculum.

This article focuses on one particular strand of the CEPAD research framework – the journey towards the identification of a threshold concept in design – and examines how the identified threshold concept sits within the process of design thinking and solutioning. The article also considers some implications of this for the enhancement of teaching and learning in the transport and product design curriculum.

Identifying the threshold concept

The threshold concept research framework was first introduced by Meyer and Land in 2003, who describe a threshold concept as:

> *... akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress.*
>
> (Meyer and Land 2003: 1)

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In more detail, threshold concepts have several, distinct, characteristics in that a threshold concept can be considered *transformative* – once a student has grasped a threshold concept, it involves a personal as well as a conceptual change; *irreversible* – once understood the student is unlikely to forget it; *integrative* – opens up the connections between the things the students have been learning and thus enables new possibilities to emerge from this under- standing, and *troublesome* – likely to involve forms of troublesome knowledge which 'appears counter-intuitive, alien ... or seemingly incoherent' (Perkins 1999 in Meyer and Land 2003: 7). Also important in terms of thresh- old concepts is the term 'liminal space': whilst students are trying to grasp a threshold concept, they experience a sense of uncomfortable intermediacy, while they struggle for understanding, and this struggle can involve identity shifts and 'troublesome, unsafe journeys' (Cousin 2006: 5).

It was therefore hoped that the framework would offer a 'way in' to the type of course that is not entirely bounded by learning outcomes – in other words, a creative course which tends to work with what Davies describes as 'ambiguous terms such as "creativity", "imagination", "originality"' (Davies 2003: 2). As such then, within this type of course, the focus may be on the critique of a 'collection' of student work in order to understand where learning outcomes have been met, rather than producing individual pieces of work to meet each learning outcome – a task which can be both overwhelming and burdensome for students in wide ranging subjects such as design. Thus, the threshold concept framework had the potential to apply 'a lens' to illuminate the transformative moments that students experience on a course which focuses on creativity, emphasizes individual agency and is also underpinned with tacit knowledge, described by a design tutor, as an 'underlying agenda of things we know the students need to have'.

The research into identifying threshold concepts in design began with a consideration of whether spatial awareness development was a threshold concept for students, as this is seen by staff as a crucial component for students who wish to successfully enter the professional design community of practice. As such spatial awareness skills are looked for in application portfolios and count greatly towards entry onto the Transport and Product Design courses.
Using the research question 'Is spatial awareness development a thresh- old concept for first year students on the transport and product design course?', students who volunteered for the longitudinal study and their tutors were interviewed to establish a definition of spatial awareness as it related to the course. A significant finding was that there was no 'one' definition of spatial awareness, and as reported in Osmond and Turner (2008), staff responses included 'all round awareness' to 'design sensitivity', whilst student responses were categorized as 'having no knowledge', 'little knowledge' and 'guessing'.

Meanwhile, a concomitant research aim was to develop a spatial awareness measurement tool and this was implemented with 114 first year students alongside an existing tool – the 'Purdue Visualization of Rotations Test' (Bodner and Guay 1997). The results of both tests were analysed[1][1], and then compared with the students' end of year assessment results, but no

[1] Statistical analysis of the results was con- ducted using SPSSTM statistical software (version 14.0). Data were checked for normality before the calculation of mean scores. Correlations were carried out using Pearson and Spearman Rank tests as appropriate
(Ho 2006).

correlation was found. In other words, the students' spatial awareness development bore no relation to their ability to successfully complete the first year of study. The research team concluded that spatial awareness development was not a threshold concept for the first year of study; further it was concluded that spatial awareness as it is convention- ally understood in the literature is not closely aligned to the form-based creativity associated with industrial design practice. From this came a shift in focus towards notions of visual creativity, and research in this area is currently ongoing.

However, a potential threshold concept did emerge from data: initially called 'the confidence to challenge', this potential concept was further investigated with staff and students during year three of the project. The 'confidence to challenge' is defined by staff as the ability to '... inculcate design conventions and expand upon them using information from a variety of sources and experiences'. Without this confidence students may get 'stuck' in Meyer and Land's 'liminal space', constantly 'surfacing around' in search of inspiration as they tackle what Buchanan calls 'wicked problems' (Buchanan 1992: 6).

As reported in Osmond and Turner (2008), evidence to support this threshold concept was found in the qualitative data produced from the student interviews in that several students reported a feeling of 'being stuck' when faced with a design brief, perhaps epitomized by this comment from a first year student:

> *I think during the very beginning I really struggled to really know what I should do in my projects – you really spend a lot of time to think about it but the result is not really that good as you expected because you keep surfacing around, you can't really make decisions about doing ... that's one of the most negative feelings because you don't know what to do sometimes – I mean I understand you do projects it is not really satisfying teachers, you learn during the process, but still you want to know what they really want.*

In one particular case, another first year student entered the second year of the course without losing this feeling, and commented:

> *If it is someone else's drawings you can bring it to life and it is a lot easier. I didn't struggle so much with the first assessment – the second assessment was more you had to design something and that is when I struggled ... even though it is a design course.*

Although this student successfully completed his second year, he subsequently left the course commenting that 'I have learnt that I don't want to be a designer and I no longer have the passion to be one' – indicating that he was, in the end, unable to trust in his creative abilities. In contrast, another first year student who displayed a lack of confidence in his designs in the first year, was able to successfully defend a design in the second, evidencing an increase in confidence in terms of coping with the uncertainty of the design process.

There are also some indications that some students do not pass through this threshold concept until later in the course, as evidenced by the experience of a final year student who, up until this point, had produced perfectly competent designs, but, after a period of intense uncertainty produced an innovative, original design for the final year degree show:

> *Normally when I design something I have a sort of vision in my head of what it is going to be and what the finished thing is going to be and usually it only takes a couple of goes to get it right and then I have to bulk out the rest of it with ideas that I made up afterwards. But this time I literally – my mind exploded – I can do anything, literally do whatever I want and I couldn't stop – I couldn't stop designing – everything I designed I was like well that's not right so I went onto a completely different one as opposed to amending the one I had already done ... [but] suddenly it was like ping! I just got an idea, I did it, we made it and ever since then I have been developing it slightly and nothing much has changed and it has all come together really well.*

The notion of 'surfacing around' or a period of uncertainty during the design process is well documented in both the design literature (see Cross 1992; Dorst 2003) and in the creativity literature (see Kleiman 2008; De-Bono 1995). It is perhaps best epitomized by this quote from Tovey:

> *It is possible that the incubation periods, that time of apparent inactivity during which the designer's brain furiously grapples with the problem, is simply the period during which the two halves of the brain are out of touch or unable to agree. But contrast the moment when they do suddenly come into alignment would be the classic 'eureka' point.*
>
> (1984: 226)

It seems that incubation period relates to Meyer and Land's 'liminal' state, and as such is part of the design process: once students recognize this as such, they have then gained the confidence to challenge design conventions and then produce innovative designs. From this, the research team concluded that it was the process *leading up to* the confidence to challenge that is the threshold concept and it has tentatively been called 'the toleration of design uncertainty'.

Discussion

Typically then, design problems are ill-defined, ill-structured, or 'wicked'. When designers embark on a piece of design they do not have all the information that is necessary to solve the design problem. In fact it is argued that they almost always lack a proportion of it, and that by their nature design problems are not susceptible to exhaustive analysis. Experience indicates that ideally the only practicable way forward is to produce a draft solution, so that the problem can be kept within manage- able bounds.

This approach seems to be core to designing and implies a whole way of understanding the world and responding to it. This has been characterized as the 'Designerly Way of Knowing' by Cross (1982), a mode of thought that has five aspects:

1. Designers tackle ill-defined problems
2. Their mode of problem solving is solution focused
3. Their mode of thinking is constructive
4. They use codes that translate abstract requirements into concrete objects
5. They use these codes to both read and write in the object languages

However, for students there is a very particular transitional stage that they need to pass through in order to feel confident enough to quickly produce a draft solution. As this article has outlined, it is possible that the uncomfortable and troublesome 'explosion in the head' needs to not only

take place, but be accepted by students as a routine – but nonetheless exciting – part of the process of producing draft solutions. That this stage is well documented in the literature indicates that professional designers recognize this experience, but up until this point this knowledge seems to have been tacit in relation to student design education. As a result, discussion is also ongoing on how to best develop support frameworks to help understand how curriculum development can be influenced by the identification of the threshold concept; with the intention of introducing learning objectives into modules that specifically address and legitimize the students' experience of uncertainty in solving design problems.

In addition, the development of a model that calls upon knowledge of the critical points of the design process is in discussion and this model would site the toleration of design uncertainty in the pre-concept design stage where exploration of the 'design problem' takes place. This will be outlined in future articles.

Conclusion

From the CEPAD research into identifying threshold concepts in design, it has become evident that within visual intelligence and the development of designerly approaches, spatial awareness itself is not a threshold concept. However, CEPAD has found that the 'toleration of design uncertainty' within the design process is a major threshold concept within student design education, which has hitherto gained only tacit recognition within the curriculum. This finding is to be used to inform future curriculum development in design as learning to deal with ill-defined problems is at the core of design thinking. The CEPAD team now aims to investigate ways that students can be supported in gaining confidence to deal with 'unknown' or 'difficult' design situations, which range from the solving of a functional design problem to the decision-making associated with the resolution of a complex form. Finally a model is in development, which sites the toleration of design uncertainty in the pre-concept design stage.

References

Bodner, G. and Guay, R. (1997), 'The Purdue Visualization of Rotations Test', *The Chemical Educator*, 2, pp. 1–17.
Buchanan, R. (1992), 'Wicked Problems in Design Thinking', *Design Issues*, 8: 2. Cousin, G. (2006), *An introduction to Threshold Concepts*. Available: http://www.gees.ac.uk/planet/p17/gc.pdf. Last accessed 10 November 2009. Threshold concepts and the transport and product design curriculum 173
Cross, N. (1982), 'Designerly ways of knowing', *Design Studies*, 3: 4, pp. 221–227.
Cross, N. (1992), 'Research in Design Thinking', in N. Cross, K. Dorst, N. Roozenburg (eds), *Research in design thinking*, Delft University Press. The Netherlands.
Davies, A. (2003), 'Writing learning outcomes and assessment criteria in art and design', *Report for the ADCLTN* (ADM Subject Centre), http://www.arts.ac.uk/docs/cltad_learningoutcomes.pdf. Accessed 10 September 2009.
DeBono, E. (1995), 'Exploring patterns of thought: Serious Creativity', *Journal for Quality and Participation,* 18: 5, pp. 12–18.
Dorst, K. (2003), *Understanding Design 150 Reflections on Being a Designer*, Amsterdam: BIS.
Kleiman, P. (2008), 'Towards transformation: conceptions of creativity in higher education', *Innovations in Education and Teaching International*, 45: 3, pp. 209–217.
Meyer, J. H. F. and Land, R. (2003), 'Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines', in C. Rust (ed.), *Improving Student*

Learning. Improving Student Learning Theory and Practice – 10 years on, Oxford: OCSLD, pp. 412–424.
Osmond, J. and Turner, A. (2008), 'Measuring the creative baseline in transport design education', In Rust, C. (ed) *Improving Student Learning – For What? Proceedings of the 2007 15th International Symposium.* held at Trinity College, Dublin. p. 87–101. The Oxford Centre for staff and learning development. Oxford Brookes University. Oxford.
Tovey, M. (1984), Designing with both halves of the brain', *Design Studies*, 5: 4, pp. 219–228.

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Submission [6]

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Developing a Pedagogic Framework for Product and Automotive Design

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Abstract

An approach to industrial design education based on 'transformative practice', which has the ambition of equipping students with a passport to enter the community of professional design practice, is described. This is mapped onto a version of the designerly way knowing which is illustrated as an analysis-synthesis model involving a conversation between the two cognitive modes, which are emphasised in various teaching activities. The uncertainty threshold, which is inherent in this, is both essential and routine, but can present problems for some students. The development of a re-designed course programme devised with a more flexible project delivery arrangement to accommodate these issues is briefly described. Its effectiveness is assessed through focus groups and feedback from early results is giving a broadly positive response to the new scheme.

Keywords

Project-grounded research, design process, industrial design, creativity, design practice, learning, reflective practices, pedagogy.

This paper outlines a particular strand of pedagogic research undertaken by the Centre of Excellence for Product and Automotive Design (CEPAD) at Coventry University. Established as the result of a successful bid to HEFCE's Centres of Excellence for Teaching and Learning initiative in 2005, CEPAD initiated several strands of pedagogic research, all of which are underpinned by Wenger's community of practice theory. Specifically the research focused on the journey of industrial design students towards successful entry to their professional community of practice. From this starting point, research was undertaken into identifying threshold concepts in design – those crucial transformations that turn students into designers equipped to engage with their professional community. This identification was then used to develop a pedagogic framework for product and automotive design. Also linked to the research are issues concerning how to foster students' visual creativity and these are discussed in a separate paper to be presented at this conference (see Tovey & Bull, 2010).

Community of practice theory

The CEPAD research is underpinned by community of practice theory (Lave and Wenger 1991). A community of practice typically comprises a group of professionally qualified people in the same discipline, all of whom negotiates with and participate in a mutually understood discourse. This

[1] Centre of Excellence for Product and Automotive Design

discourse is both explicit and, very often, tacit and the signs of membership are usually unmistakable. (Osmond, 2010)

Lave and Wenger also highlight a theory of learning as being our 'lived experience of participation in the world' (Lave and Wenger 1991, Wenger 2007): that is, our learning takes place through a deepening process of participation within a community of practice, and even our identities are formed from this participation. Wenger defines the major principles of a community of practice in three separate, but related quotes:

> *Communities of practice are groups of people who share a concern or a passion for something they do and who interact regularly to learn how to do it better.*
>
> *A community of practice is not merely a community of interest – people who like certain kinds of movies, for instance. Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems – in short, a shared practice.*
>
> *In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other.*

Thus within a community of practice learning can be seen as an experience of identity formation: it is not just an accumulation of skills and information, but also a process of becoming – in this case a certain kind of creative and critically minded design practitioner. (Osmond, et al 2007) It is through this “transformative practice”, as Wenger calls it, within a professional community of creative design practitioners that learning can become a source of motivation, meaningfulness and personal and social energy.

Design Communities

Designers come in many types, for example architects, industrial designers, design engineers, graphic designers, interaction designers, fashion designers, interior designers, craft designers, furniture designers and jewellery designers. Each of these represents a significant group of practitioners and each one can be regarded as a community of practice. Some of the categories are sufficiently large that they subdivide into groups of more specialist designers, for example graphic designers might distinguish between those concentrating on corporate identity, media graphics, or information design. Similarly industrial design contains the large sub-categories of product design and automotive design, and smaller groups such as boat designers.

For key groups there are formal bodies to which entry is by examination – for example, in relation to architects there is the Royal Institute of British Architects in the UK, and the Society of American Architects and the American Institute of Architects in the USA. For a wide range of design professions in the UK there is the Chartered Society of Designers and in the USA the Industrial Design Society of America. Most such societies are national and tend to have national membership, but less formal groupings can be international in scope and a powerful example of this is the community of practice of automotive designers.

The International Community of Practice of Automotive Designers

There are car design studios in all of the major industrial countries of the world, and in most of the world's continents. The designers who work in these studios typically share their passion for automobiles and each time a new vehicle concept is revealed by one studio it causes interest and excitement in others. Although during the development of a new design there is usually great secrecy in the company concerned, a great deal of information is shared throughout the industry, and companies often move in similar directions, responding to common pressures from the market and governments (Tovey and Owen, 2006).

For an international community to function it is important that there is communication between its members. For automotive designers this is supplemented by online resources such as the Car Design News (CDN) website. This was created by three car designers from both the USA and the UK and contains news from a designer's perspective of developments in car design, with in-depth

reviews and an extensive on-line gallery from all of the major car shows. CDN also features student exhibitions and competitions, discussion forums, resources and job listings, a large on-line collection of car designer portfolios, (paid for) members editorial and a car design taxonomy. With over a million hits a year CDN is a highly effective device for facilitating the community of practice.

Designerly ways of knowing

A working assumption in CEPAD is that - within the design community of practice - designing ability can be described in terms of both generic capabilities and specialist capabilities. The generic capabilities are those that are shared by designers across a wide range of specialisms and the specialist are those areas of domain-related knowledge that distinguish designers in particular areas.

In the practice-based approach to design education we suggest that the intention could be seen as one of combining the generic capability with domain related specialised knowledge, to produce a level of capability sufficient to gain entry to the relevant community of design practice. The portfolio of work could then be characterised as the passport to enter that community (figure 1).

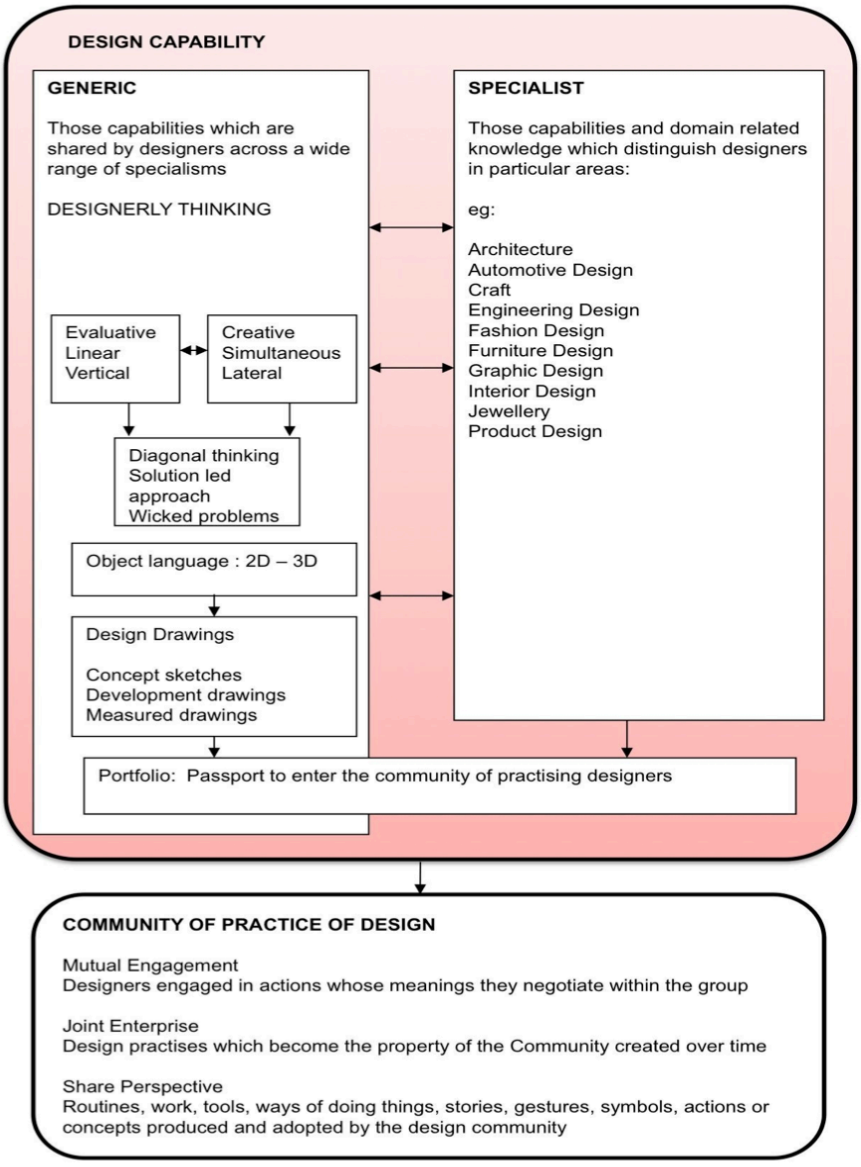

Figure 1 Design Capability Model

In order to develop this 'passport' there is a long tradition of teaching design through 'transformative practice' in which students' educational experience is centred on tackling design problems that become progressively complex. This practice-focused education is reinforced by real world design experience and CEPAD's engagement with this community has been developed and evaluated through industry involvement in course work, placements and internships and university-based consultancy. From this professional engagement comes the picture of designing ability described in terms of both generic and specialist capabilities.

However, although there are specific skills and areas of specialist information that mark out product design, graphic design or architecture for example, there are also important commonalities. One of the most important – generic design thinking capability – has been labelled by Cross (2006) as 'The Designerly Way of Knowing'.

Cross describes this capability has containing five aspects:

- Designers tackle ill-defined problems
- Their mode of problem solving is solution focused.
- Their mode of thinking is constructive
- They use codes that translate abstract requirements into concrete objects.
- They use these codes to both read and write in the object languages.

It is in the character of design problems that they tend to be ill-defined, ill-structured, or 'wicked' (Buchanan 1992) and designers may not have all the information necessary to solve them. To cope with this lack of information, experience indicates that the quick production of a draft solution will allow a definition of the limits of the problem and the provision of a basis for developing an idea or ideas further. To quote Cross (2006)

> *In order to cope with ill-defined problems, the designer has to learn to have the self confidence to define, redefine and change the problem-as-given in the light of the problem that emerges from his mind and hand. People who seek the certainty of externally structured, well defined problems will never appreciate the delight of being a designer…*

The production of a solution conjecture at an early stage in the process could be said to facilitate the re-examination of the problem by providing the spectacles through which to look at it. The designer is able to tell where she or he needs more data because without it the design cannot move forward. In some areas of design this solution-focussed strategy is fully formalised in the way in which the design activity is managed, for example at an early stage in the process there will be a requirement for a 'Concept Design' which is the designers' attempt to provide a sketchy representation of what the finished design might be, or might look like. If the designer or design manager sees the concept as providing a basis for proceeding then the structure of the rest of the process falls into place. This is the solution-led approach, which has, at its core, the process of moving from an abstract statement to a visual object. The designer learns to think in a sketch-like form, in which the abstract patterns of user requirements are turned into the concrete patterns of an actual object. Thus the designer uses a code to effect this translation from individual, organisational and social needs to physical artefacts. This is the use of the visual language of designing, employing its translation codes, and is the match of the analytical (left hemisphere) statement to the holistic (right hemisphere) solution. The manifestation of this outcome will be a visual representation, a drawing, a 3D or virtual model.

Developing a Pedagogic Framework

The Analysis-Synthesis Model

This picture of the thinking processes involved in designing corresponds with the classic analysis-synthesis description of the design process. Such a dualistic characterisation corresponds with the view of brain function which orders cognitive activity to align it with the different characteristics of the two halves of the brain, or cerebral laterality. In the substantial work on this many researchers in this field have characterised the two parts of the brain as separate information processors and

encoders. There is strong evidence for the view that underlying the left hemisphere's dominance for expressive speech and the right hemisphere's dominance for manipulospatial activities are different processing modes. Typically the modes are characterised as analytic-synthetic, linear-holistic, serial-parallel or focal-diffuse for the left and right halves of the brain, respectively. This dichotomy is attractive as it seems to correspond with the different types of cognitive style identified by psychologists in problem-solving procedures.

It is clear that for anything other than very simple mental operations, both halves of the brain are involved, as has been shown in EEG maps of cerebral activity during experimental tasks. It would seem that the two processing modes are typically employed at the same time and interactively, and that a more complete understanding of any particular problem arises from the matching of initially separate simultaneous mental operations.

It is possible that design thinking may be organised in a similar way, with two simultaneous interacting cognitive styles being employed. Thus it would be expected that an analytic, linear strategy would be at work in the process of data generation and organisation to yield a design specification, and also in the evaluation of design proposals. In parallel with this a synthetic-holistic strategy, used in the generation of solution conjectures, would be the integration of visual relationships and the physical representation of the design as drawings or 3D models.

These two interacting lateralised mental operations can be used to map out design thinking and help understand it. Tovey (1984) has called this the dual processing model of the design process. In it there is the assumption that the two halves of the brain will both be involved in solving the design problem, each half working in its own preferred information processing mode, each tending towards its favoured modelling language, the left in words and symbols, the right in drawings and 3D models.

In order to offer a way of characterising some of the key areas identified in our investigations into design pedagogic process Figure 2 maps the industrial design programme activities onto the dual processing model.

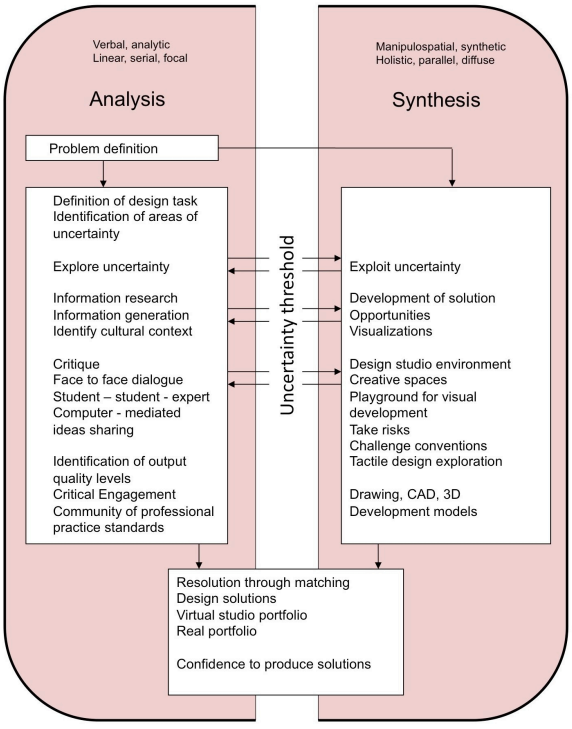

Figure 2 Analyses – Synthesis Modes

Identifying threshold concepts in design

As outlined above, this 'dual processing' strategy is routinely employed by designers, involving a 'conversation' taking place between the left-brain (convergent, reflective, field dependent, serialistic) and the right-brain (divergent, impulsive, field independent, holistic). The result of this 'conversation', in what Tovey describes as an 'incubation period', enables a designer to arrive at a 'solution':

It is possible that the incubation periods, that time of apparent inactivity during which the designer's brain furiously grapples with the problem, is simply the period during which the two halves of the brain are out of touch or unable to agree. But contrast the moment when they do suddenly come into alignment would be the classic 'eureka' point.' (1984: 226)

However, qualitative data from the CEPAD longitudinal study into identifying threshold concepts in design with a cohort of industrial design students from entry (2005) to graduation (2009) showed that some students, presented with typical 'wicked' design problems may get stuck in this 'conversation'. Often students are trying to satisfy what they think tutors want rather than trusting their creative abilities and those who do not get beyond this lack of trust can remain in what Meyer and Land describe as a 'liminal state'. In this context a liminal state relates to the notion of a threshold concept, which Meyer and Land define as:

> *… akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (2003:1)*

As such then students can be stranded within a liminal space while they struggle for understanding and this struggle can involve identity shifts and 'troublesome, unsafe journeys' (Cousin 2006:5); in other words they will experience a period of intense uncertainty. As reported in Osmond et al, 2010, a threshold concept also features other characteristics: it is *transformative* in that it involves a personal and a conceptual change; *irreversible* in that it will not be easily forgotten; *integrative* in that it allows hitherto unrelated knowledge to 'slot into place', and *troublesome* in that it appears 'appears counter-intuitive, alien…or seemingly incoherent' (Perkins 1999 in Meyer and Land 2003:7).

In order for students who are 'stuck' to move beyond a liminal state they need to experience a unforgettable, integrative and troublesome transformation - almost a leap of faith - to navigate this uncertainty, and if they do not, they are unlikely to possess the confidence to challenge design conventions, produce solutions and thus innovative designs. However it looks as if once students accept that each time they approach a design brief they will experience this uncertainty they can then use the tools and methods inculcated within their programme to harness their thoughts and ideas and begin designing. In essence, the research identified a threshold concept, which CEPAD has labelled as 'the toleration of design uncertainty', defined as:

> *…the moment when a student recognises that the uncertainty present when approaching a design brief is an <u>essential</u>, but at the same time <u>routine</u>, part of the design process.*

From this analysis the notion of providing a safe 'creative space' in which the students could experiment and experience intense uncertainty within a supportive environment emerged. Indeed it was considered that this represented a key change for the curriculum and that the design programme should be revised to incorporate both scheduled time and physical space to allow it to happen.

The revised design programme

In 2009 the creative space idea was incorporated into a course review process for the industrial design programme, which resulted in the introduction of a new and fundamentally revised curriculum design for the academic year 2009-2010. This new scheme also capitalised on the analysis of data gathered from student course consultative committee meetings, special focus groups with external examiners, leaders in the School, and designers in professional design studios.

In particular, major changes were introduced that addressed the modular structure of year 1 and year 2 of the course in that the existing eight-module provision was replaced with an arrangement incorporating one quadruple practice module, which spanned the whole year. In keeping with this, the assessment requirements for the new module now take the form of staged gateways, attached to a number of briefs associated with a range of key 'drivers of design' such as branding, sustainability, historical context, user needs, technical advances and cultural differences. Some briefs have been designed to be 'tight' and others to be 'open'; the latter designed to encourage and develop students' creative abilities. To this end, the weightings given for marks in each assessment have also been staged and graduated to encourage a 'creative' journey, with the first assessment attracting only 10% of the mark for the year, the second only 15% and the final 75%. The aim is to allow the students space to experiment with their designs and then put forward their 'best' work for the final 75% assessment. In addition year 1 and year 2 students are given a specific studio space to work within and colonise as their own.

Student feedback

In December 2009, a series of focus groups and one-to-one qualitative interviews were carried out with eight year 1 and six year 2 students in order to capture their experiences of the new curriculum design. Open-ended questions were used around the themes of assessment, feedback and the new 'creative space'.

The findings showed that the first year students were, on the whole, enjoying the creative space and freedom they had been given:

> *I have to say I do like it – I like the relaxed style of teaching it makes you feel more comfortable and it feels like you can express yourself a lot more and the course is designed around you instead of a specific standard that is supposed to fit every kind of ideal person.*

At the point at which the focus group took place, the students had yet to receive a summative assessment mark (although they had received two instances of formative assessment), which was in contrast to some of the students' previous educational experiences, which could be characterised as very structured:

> *In the beginning [of the BTEC] we got a list – and the criteria of what gets merit, what gets distinction and if you do all of them, you get the grade basically*

This change was reflected in their current experience, which is very far from 'trying to tick boxes':

> *It is not a case of just trying to tick the boxes - which they keep drumming into us - you are not going to tick the box you are going to develop your own ideas.*

The students were asked if they found the increased independence they were experiencing caused uncertainty in tackling design briefs, and one did feel that this could be problematic as 'you don't know where you stand', but another, whilst acknowledging this, felt 'it was good because it drives you on.' Another pointed out that their tutor had gone to great lengths to make sure not only that they understood the brief, but also to make sure that they related to the brief in terms of their own ideas and thus gained 'ownership' of their designs.

The second focus group, which took place much closer to the first formative assessment gateway, did result in some anxiety being evidenced by the students about the vagueness of the briefs, although some students thought that the briefs were 'deliberately vague':

> *I think also that the way they have structured it with the freedom, because if they drilled it into us you have got to do this, this and this, I don't think it would give us the chance to develop our own style as much, so with the freedom we can have a chance to work on that a lot more*

Again, some of the students put the ability to embrace the freedom down to previous educational background, with some having experienced the same kind of freedom in 6th form college, and others working to a tick box system:

> *There are a couple of people that I have heard that do want to be spoon fed and have*

come straight out and said tell me what to do and I will meet the criteria if you tell me what to do, but from day one I know that it has been drilled into us that they are not going to tell us what to do, they are expecting us to get pro-active with it

One student did recognise that the transition from student to designer took place when 'you have got past that bit where you want to just fill in tick-boxes' but again another pointed out that, depending on previous experiences, some students might need more help:

I think you have to appreciate at the same time, everyone has different levels of stages where they can just go and do that, some people who do need that support more than others

Overall though, despite some anxiety being expressed about the freedom of the new style curriculum, the first year students appeared to be enjoying the creative space they had been given. However, as the focus groups took place at the end of the first term of the new curriculum and before the first summative assessment we can only speculate that this would continue. Having said this, the comparison with the responses of the 2005 cohort during their first interview is quite striking. Most of those responses concerned meeting deadlines, and as their first year progressed, a particular task entitled the 'thought receptacle' proved troublesome for the students. As reported in Osmond (2007) the task was designed to foster creativity and encourage the students to experiment with ideas. However, several students failed this task and comments in relation to staff feedback included: 'I really thought I had understood [the thought receptacle] – but from the feedback I hadn't. Apparently it was too planned'. Another reflected that: '[the thought receptacle] should reflect your personality and music I liked and sometimes poems and wrote down a lot of … but it wasn't much so then later on [the lecturer] said relate to design as well…the creative thing wasn't really set in.'. This was echoed by staff comments in relation to this assessment, which identified a 'limited sense of personal point of view, …distance from being a designer, lack of confidence.' and 'not much personal stuff coming through.'

For the year 2 students interviewed, it appeared that the new curriculum had already made an impact in that they had just completed their first piece work and that attracted a summative mark of only 10% of the total for the year. Firstly, several of the students had experimented with designing different vehicles in order to improve the variety of their portfolios, with one stating that 'if it had been a higher percentage I would have thought of sticking to what I know.' Another found that because the mark was such a small percentage that he could spend time on sketching, which allowed him to 'get better at the design process':

I had a sketch book and I was constantly sketching, sketching and I noticed that my sketching did improve from the beginning to the… at the very beginning I was quite scared and drawing very neatly oh no i don't want to make a mistake but later on got more free and didn't really care and that is when I got my best bits when I was – there was a point where I was really angry I just couldn't get a design and really angry and scribbled and oh actually that's quite good…

Secondly, for another student who felt he had performed poorly at this task, the 10% mark was a relief because he could use the feedback he received in a constructive manner for his next assignment.

In a way I am glad because I don't think I did very well…I think if I ever did something like that again, I would probably have a better stab at it…

In addition to this marking system, a new 'buddy' assessment method was introduced where students who were not presenting their work were asked to write down feedback given to the student presenter; this would allow the tutors to enter into a conversation with the students about their work without also having to write down every comment. Also, the summative mark for the assessment was not given until a week after the presentations.

The students felt that this system was excellent as they not only received good quality feedback, they also had a record of it and got to see feedback given to other students which allowed them to 'see where you are at and where your peers are at and whether you are doing good or not so good – and if they are doing better, you want to do better'.

This is in contrast to the 2005 cohort responses during their first interview during their second year where some students had problems with understanding the brief that was set:

> *My main problem - especially the ones that I only just passed they said I didn't understand the brief - I had obviously read it and gone out and done my own thing and completely forgotten about it and not stuck to the brief at all - that was the main problem*

Finally, some of the students could not see the 'join' where all the modules intersected within the previous curriculum design and thus found it difficult to design 'holistically':

> *I don't really like the idea of splitting things up…I don't really like the way some of the modules are done this year…because they are splitting up disparate parts of the design process and they are not bringing them together at the moment.*

In summary, the qualitative research with the first and second year students showed that they were enjoying the new creative space afforded by the newly designed curriculum evidenced by the lack of 'deadline panic' that was apparent in previous years and by a willingness to experiment when faced with a design brief. However there are indications that some students are finding the provision of such an 'open' space difficult and this may well be linked to previous educational background. However the study sample was a small percentage of the total number of students, and the data gathering took place at the end of the first term, so cannot be seen to be representative of the experience of all Year 1 and Year 2 students or representative of a complete study year experience. To address this, more data is to be gathered at the end of Term 2 and Term 3.

Conclusion

It seems that part of the mutually understood discourse of the professional design community of practice is what Cross aptly calls 'The Designerly Way of Knowing': the recognition that design problems will always be 'wicked' and therefore problematic, and possession of this knowledge is a passport to the professional design community of practice. In more detail, Tovey posits that the thinking process that underpins this 'knowing' involves 'dual processing', where two parts of the brain have a 'conversation' with each other, which then produces a quick solution that can be built upon and expanded.

However, the CEPAD research found that some students get stuck in the 'conversation' between the cognitive modes associated with the two halves of the brain and consequently cannot move quickly towards a draft solution. This may be because they are trying to divine what the tutors want or because they do not trust their creative abilities enough to recognise that the conversation and draft solution is an essential part of the design process. From this the identification of the 'toleration of design uncertainty' as a threshold concept was made in order to provide a benchmarked portal for students to pass through on their journey towards becoming a designer. In other words, once the students recognise that the conversation and the process of drafting a solution involves experiencing design uncertainty and that this is an essential but routine part of the design process, they then can move on towards experimenting, innovating and playing around with design conventions. In recognition of this a new design programme was introduced for the students, which was designed to encourage creativity, and early indications are that the new 'creative space' is indeed fostering the students' creativity. However, there are also some indications that students from a 'rigid' or 'tick-box' educational background may experience difficulty with such a creative space and more research is needed in this area.

Overall the CEPAD research has enabled an essential threshold concept to be identified and explicitly surfaced within the curriculum and a pedagogic framework developed in order to support student designers on their journey to assuming the identity of professional designers. The ability to work with the toleration of design uncertainty is a quality exhibited by established designers, and is part of what is shared within the community of practice. The intention is to research further the utility and impact of the new programme design on students' creative confidence and on the extent to which it develops capabilities which are in line with the aspiration to achieve entry to the community of professional practice. It is anticipated that this will involve a process of adjustment and fine-tuning.

References

Buchanan, R. (1992) Wicked Problems in Design Thinking, *Design Issues*, 8: 2.

Cross, N. (2006) *Designerly Ways of Knowing*, Springer-Verlag. London

Cousin, G. (2006), *An introduction to Threshold Concepts*. Available: http://www.gees.ac.uk/planet/p17/gc.pdf. Last accessed 7 January 2010.

Lave, J., Wenger, E. (1991) *Situated learning, Legitimate peripheral participation*. Cambridge University Press.

Meyer, J.H.F. and Land, R. (2003). Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines. In C. Rust (Ed.), *Improving Student Learning. Improving Student Learning Theory and Practice — 10 years on*, OCSLD, Oxford, 412-424.

Osmond, J. (2010) Passports to a community of practice. In Tovey, M. ed. *Design for Transport*. (in publication)

Osmond, J., Bull, K., Tovey, M. (2010) Threshold concepts and the transport and product design curriculum: reports of research in progress. In Art, Design & Communication in Higher Education. Volume 8. Number 2. Intellect Ltd

Osmond, J., Turner, A. & Land, R. (2007) Threshold Concepts and Spatial Awareness in Automotive Design. In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam

Tovey M., Bull, K. (2010). Visual Creativity and the Threshold of Uncertainty in Product and Automotive Design. To be presented at the *2010 Design Research Society (DRS) international conference Design & Complexity*, July 7-9. Montreal.

Tovey, M. (1984) Designing with both halves of the brain. In *Design Studies*, Volume 5, Number 4. October. pp 219-228. Elsevier.

Tovey, M. and Owen, J. (2006) Entering the Community of Practice of Automotive Design. In Proceedings of the *Sixth International Symposium on Tools and Methods of Competitive Engineering.* Delft : University of Technology; Ljubljana : University of Ljubljana

Wenger, E. (2007) *Communities of Practice learning, Meaning and Identity*. Cambridge University Press.

Author Biographies

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A graduate of the RCA, Professor Mike Tovey was in industrial design practice prior to entering education. In 1973 he joined the institution which was to become Coventry University, as a lecturer in industrial design. He was appointed to Head of Industrial Design in 1985 and in 1989 was made Dean of the Coventry School of Art and Design. In 2007, he changed position to take on the University-wide post of Director for Design. Professor Tovey is responsible for developing courses and applied research in design across the University and is Director of the Centre of Excellence in Product and Automotive Design (CEPAD).

Dr Karen Bull

Dr Karen Bull is Deputy Director, Centre of Excellence in Product and Automotive Design at Coventry University. This centre focuses on evaluating spatial design understanding and identifying the transformative threshold concepts associated with students entering the Global community of practice for industrial design. Her expertise is in industrial design theory, design analysis and design context. Her background is in product design and her PhD is titled Advanced Personal Telecommunications Products and Industrial Design'. She has continued to research pedagogy in relation Art and Design and is especially interested in the area of critical and reflective learning, e-teaching and learning and e-portfolio.

Jane Osmond

Jane Osmond is Senior Research Assistant for the Centre of Excellence for Product and Automotive Design (CEPAD), Coventry University and is researching students' spatial awareness skills, threshold concepts in design and internationalisation of the curriculum. Jane is undertaking a PhD by research in this area, and has published several papers on threshold concepts including: Osmond, J., et al (2009) 'The Threshold Concept Journey: from identification to application'. *From theory to practice*. Sense Publishers. Rotterdam [in publication]; Osmond, J. et al (2008) 'Measuring the creative baseline in transport design education.' In Rust., C. (ed) *Improving Student Learning – For What?* OCSLD. Oxford; Osmond, J. et al (2007) 'Threshold Concepts and Spatial Awareness in Automotive Design.' Land, R., & Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam. Previous projects include: 'Improving Retention, Supporting Students'; 'Mapping Equality & Diversity Initiatives in HE' and 'Meeting the Challenge: Managing Equality & Diversity in HE.

Submission [7]

Osmond, J. (2011) 'A ‘Wicked’ problem for a 'Wicked’ Discipline'. Researching Design Education: 1st International Symposium for Design Education Researchers. CUMULUS // DRS 2011. Held on 18-19 May in Paris, 141-155

CUMULUS // DRS SIG on Design Pedagogy
1st International Symposium for Design Education Researchers
La Bourse du Commerce, Paris 18–19 May 2011

Jane Osmond (2011). *Researching Design Education a 'Wicked' Problem for a 'Wicked' Discipline*. 141–155

Researching Design Education a 'Wicked' Problem for a 'Wicked' Discipline

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This position paper extrapolates the experience of researching the ways of thinking and practicing in an UK industrial design course into the wider context of the recent UK government announcement that the Higher Educational teaching budget will no longer exist from 2012 for Humanities subjects, within which the creative disciplines sit.
The paper argues that this decision could be seen a direct consequence of a lack of published educational research within the creative disciplines, a situation that is due to creative arts subjects historically being vocational in nature and delivered by practitioners, rather than academics.
As such an educational research culture has been slow to evolve and is concomitantly patchily resourced, with creative arts disciplines still, in some cases, positioning themselves 'outside' the academy, operating within a lack of a widely agreed boundary of knowledge, passing on knowledge via tacit agendas and thus resisting 'easy' measurement.
The author argues that the consequences of not having a firm baseline of published educational research has left creative arts disciplines undefended against government cuts which have privileged the 'less messy' or more easily measurable sciences, and this in turn has also left them undefended against their internal institutional marketplaces.
The paper concludes that against the current economic backdrop the role of groups such as the Design Research Society will be crucial in offering a legitimate space for the building of a solid body of educational research that demonstrates the importance of creativity in underpinning a vibrant, critically minded society that does not depend on a science/humanities divide.

Keywords: art and design; creativity; threshold concepts; UK spending review; educational research

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Introduction

From 2005-2010 the author was involved in identifying threshold concepts in industrial design for the Centre of Excellence for Product and Automotive Design (CEPAD) at Coventry University. The research gathered qualitative data from 90 design student interviews and a series of focus groups. Two whole-staff meetings were also held, alongside one-to-one interviews with nine members of staff.

The results of the research to date has been published as a series of papers and book chapters (Osmond et al 2010; Osmond and Turner 2010; Osmond 2009; Osmond and Turner 2008; Osmond et al 2008). In addition, an overall view of the journey and subsequent identification of the threshold concept entitled 'the toleration of design uncertainty', is also outlined in a paper presented at the 2010 Design Research Society Conference held in Montreal (Tovey et al 2010).

However, this position paper focuses on a theme that emerged from the research, which then found echoes in anecdotal discussions at creative arts conferences during the five-year period of research: namely what appeared to be the lack of a fully supported culture of educational research into teaching and learning practices within the creative arts disciplines[*] [†]. The paper then considers the consequences of this in the current economic climate, and the concomitant role of groups such as Design Research Society in increasing the range of published materials available.

Background: tacit teaching and learning practices

The Centre of Excellence for Product and Automotive Design (CEPAD) research took place as a result of a successful bid to the Higher Educational Funding Council for England (HEFCE) in 2005 under the Centre for Excellence in Teaching and Learning Initiative (CETL). The research, carried out with Industrial Design staff and students, concentrated on three particular strands – student development of spatial awareness skills, identification of threshold concepts in design and internationalisation of the design curriculum.

The initial research concentrated on student spatial awareness development; however very early on, it became apparent that the teaching and learning practices within the industrial design department at Coventry

[*] *The term creative arts used in this paper is meant to denote the full range of creative disciplines within the Art & Design domain; in addition the use of the term 'educational research' is defined, after Meyer and Land (2003) as research that takes into account 'the ways of thinking and practising within a discipline'. This is distinct then from research that examines the design process, for example, or research that is carried out by practitioners in order to inform the development of a new artefact or 'a description of practices' (Shreeve 2009:126).*

University were, in the main, informed by a tacit, 'underlying agenda of things students needed to have', rather than being grounded in an established working body of knowledge.

This was reflected in the early finding that spatial awareness development, initially seen as a threshold concept by the staff, was in fact, not specifically explored during the first year of the course. Further, a definitive staff view of the meaning of the term 'spatial awareness' did not emerge within the context of the course, which led to a debate over meaning during a whole-staff meeting, and individual staff interviews. A search of the literature underlined this lack of common agreement in that a number of terms are offered, including Spatial Awareness (Karnath et al. 2001), Spatial Functioning (Temple and Carney, 1995), Spatial Ability (Garg et al. 1999), Spatial Orientation (Bodner and Guay, 1997), Spatial Visualisation Ability (McGee, 1979 cited in Alias et al., 2002) and Spatial Intelligence (Eliot 2002; Gardner 1983; Shearer 2004).

This lack of clarity in relation to a definitive meaning of spatial awareness development in this context is perhaps because spatial awareness is, in the words of one teacher on the programme, 'Not something that designers acknowledge or talk about because it is the natural world they inhabit.' Another commented that 'it is an intuitive skill you develop, especially through experience.' Because of this lack of agreement, and a concomitant finding during the second year of research that the results of both a conventional and specifically designed spatial awareness test bore no correlation to students' end of year assessments results, this particular aspect of the research subsequently changed focus to notions of visual creativity.

By the second year then, the research had established that one of the cornerstones of the industrial design course – spatial awareness development, which was looked for in entry portfolios and considered a crucial component for students in becoming successful designers - did not have a commonly agreed definition within the course, and could not be correlated with concomitant meanings of spatial awareness in the literature.

This author argues therefore, that carrying out research into the teaching and learning practices within a hugely successful course was beginning to pay dividends in terms of what was, and what was not, a cornerstone of the course. This reshaping of thinking continued throughout the research period and ended with a complete redesign of the curriculum, which was based on a clearly articulated and agreed threshold concept.

Details of the journey towards the identification of the threshold concept has been published as a series of book chapters and papers (Tovey et al 2010, Osmond et al 2010; Osmond and Turner 2010; Osmond 2009; Osmond and Turner 2008; Osmond et al 2008), but in essence the threshold concept identified has been labelled as 'the toleration of design uncertainty'.

This uncertainty relates to Tovey's (1984) notion of a 'dual processing' strategy that is routinely employed by designers, akin to a 'conversation' between the left-brain (convergent, reflective, field dependent, serialistic) and the right-brain (divergent, impulsive, field independent, holistic). The result of this 'conversation', or what Tovey describes as an 'incubation period', is the arrival by the designer at a solution.

However, the research showed that some students, presented with typical 'wicked' design problems may get stuck in this 'conversation' and those who do can remain in what Meyer and Land describe as a 'liminal state'. In this context a liminal state relates to the notion of a threshold concept, which Meyer and Land define as:

> *... akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (2003:1)*

As such then, some students can be stranded within a liminal space and experience a period of intense uncertainty, and it is the toleration of this uncertainty that facilitates creative breakthroughs during the design process. Thus the threshold concept was labelled as 'the toleration of design uncertainty' which is defined as:

> *...the moment when a student recognises that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process.*

From this analysis came the notion of providing a safe 'creative space' in which the students could experiment and experience intense uncertainty within a supportive environment, and this represented a key change for the design curriculum.

The point to be made here though, is that the identification of threshold concept was not a 'bolt out of the blue' realisation; rather it was a culmination of all the data gathered from two whole-staff meetings, one-to-one interviews with members of staff and 90 student interviews. Therefore, using the threshold concept framework as a research method allowed the emergence of the hitherto hidden 'episteme' of the course. Perkins defines an episteme as 'a system of ideas or way of understanding that allows us to establish knowledge' (2006: 41-42), and argues that all disciplines have their own characteristic epistemes, which are often hidden, but can shape people's sense of whole disciplines. Perkins goes on to argue that a tacit episteme,

when not surfaced, can be problematic for students in that 'many students never get the hang of it, or only slowly'. (IBID: 43)

Bearing in mind the experience of this educational research process at Coventry University, the author began to speculate as to how much educational research was taking place elsewhere in the creative disciplines. Attendance at several conferences indicated that, anecdotally, there were barriers to this, and an example was found during a session presenting the threshold concepts research at the Teacher's Academy Conference run by the European League of Institutes of the Arts (ELIA) in 2007. When asked about research into their teaching and learning practices, the overwhelming reaction from the audience was 'how lucky [the course was] to have the funding to carry out such research'. Also, when asked if they would consider writing up their own teaching interventions in the classroom as research, the majority of the audience felt this was 'too scary' as 'they had no idea how the publishing system works', and' wouldn't know where to start'.

This was also the case at the Group for Learning in Art and Design (GLAD) conference in 2009: again the lack of a educational research was reflected in similar remarks, epitomised a paper by Alison Shreeve (2009) which outlined the importance of educational research into art and design outlasting the CETL closures. However, Shreeve acknowledges that one of the barriers to this type of research was the sheer workload expected of tutors:

> *The emphasis on a quality learning experience for students, the quest for excellence and striving for recognition and status, the expectation that they will be involved in research and/or consultancy in their creative practice, and the constant challenges of budgetary constraints, pressures of time, space and new technology all add an almost impossible burden for the full-time tutor.' (2009:126)*

Another barrier articulated by a conference attendee was 'assumed knowledge'. 'Assumed knowledge' in this context relates to the fact that design lecturers are assumed to know '...the ins and outs of conducting research and where to publish'. This attendee felt that she '...did not have any of this assumed knowledge on starting [the job] and have had to learn by asking others for advice.' These comments were echoed by another design lecturer who said, that up until very recently, there was no real expectation that design staff had to carry out and publish research, indeed, in this particular institution, specialised researchers were employed to do this to 'satisfy the RAE requirements'.

At a different institution, staff were exhorted to research and publish in their yearly appraisals, but they felt they were not given the resources or knowledge to do so. Others confirmed that they were allowed one day per week as a designated 'research day' but this often got overtaken by events. Further, even if the research day could be used to gather evidence and do the required reading, there was not then a concomitant block of time provided to write up the research. This situation is compounded by a lack of research and/or teaching assistant support; however, this could also prove problematic because of the need for particular specialisms within the field.

Educational research in creative arts disciplines

Therefore, for this author, there was, and is, a general sense that although creative arts disciplines are successful in facilitating creative and critically minded practitioners, there is a paucity of published educational research into the teaching and learning methods that underpin this success, and this is often underlined by the lack of an established educational research culture within institutions.

That an established educational research culture is hard to identify within the creative arts is not surprising when, in comparison with more established higher education disciplines such as science, history, and economics, creative arts disciplines are a relative youngster, with, for example, Art and Design courses only gaining degree status in the late 1960s (Bird 2000).

Before this, courses were firmly located away from the academy in independent Art and Design Schools, first set up in 1837. Ritterman argues that a lot of specialist art institutions still feel that they don't 'naturally belong' in the higher education sector, and that the pressures of externally-and internally imposed demands, which Watson (quoted in Ritterman 2010) refers to as the three 'alternative macrocosms' – the immediate environment, the higher education mainstream and the global higher education system - gets in the way of their 'core business'. Ritterman goes further and states that 'it is not unknown for specialist arts institutions to seek to promote their attractions through reference to an 'anti-academic' approach'. (2010: 34).

In addition, Art and Design schools were originally set up to train people to serve industry (Bird 2000) and so were historically seen as vocational, and indeed, the Coventry School of Art & Design is of this ilk, being established in the 19th Century with a remit of educating 'people to be designers'. (Tovey 2011)

Cross posits that this 'vocational sensibility' is still to be found today when he states that design teachers have '...traditionally...been practicing designers who pass on their knowledge, skills and values through a process of apprenticeship...These design teachers tend to be firstly designers, and only secondly and incidentally teachers.' (2006: 3) This practitioner focus is evidenced by Doy (2008) who found that there was a lack of scholarly

activity surrounding RAE returns in that 'it emerged that some designers and other practitioners were not accustomed to writing in a theoretical, scholarly way about their work or presenting it as research'.

Alongside both this 'outsider' identity and vocational sensibility, Joseph (2008) suggests that within the domain of Design, 'the contradictions and tensions that exist between various theories, practices and cultures of Design, and the lack of any widely agreed to formal knowledge framework suggest that, as well an ill-structured and undisciplined domain'. Poggenhol (2004) echoes this in that he argues there is a lack of consistency on 'key terms and their meaning, on what constitutes core knowledge' and for Buchanan (2001) the literature surrounding the domain is ' filled with contrasting and sometimes contradictory definitions of design'.

Further, within this 'ill-structured' domain, the teaching and learning practices can be based upon tacit knowledge, which concurs with the findings of the CEPAD research that identified an 'underlying agenda of things the students need to have' that informed the Industrial Design course, and is also echoed in a study by Cowdroy and Williams (2006) which found that design teaching tended to be based on 'what the teachers liked'.

And this is the crux of the matter – creative arts disciplines sometimes position themselves 'outside' the academy, can still retain a vocational sensibility, do not tend to operate within a widely agreed boundary of knowledge, are inclined to pass on knowledge via tacit agendas and thus can be considered to resist 'easy' measurement. This being the case, researching the ways of thinking and practising within the creative domain could be considered somewhat problematic. Any attempt to pinpoint the crucial and important learning themes within a domain that is characterised by a focus on creativity, itself a shifting, evolving and contradictory terms with many definitions, seems doomed to failure. Indeed, Nigel Cross (quoted in Sonalkar 2008), perhaps one of the most recognised design researchers, argued that a 'new paradigm for design research' was needed: one that allows the discipline to be studied in a way that does not strip it of its spirit, and its complexity.

Meanwhile, Hatton, in order to address the 'little available material of more recent design education based research...whilst at the same time knowing that there must be many kinds of research going on in the various institutions involving local action research and case studies of pedagogic practices.' (2008: Forward) instigated a conference in 2007 specifically to address the paucity of published educational research data within the domain.

This paucity of published material is especially ironic given that some of the teaching and learning practices employed within the creative arts disciplines are already used within other, more established, disciplines. A prime example of this is studio-based learning which privileges 'learning by

doing'. Gosling, as far back at 1985, argued that medical students, engineers and social workers in the clinic, lab or field are, in fact, practising the kind of 'learning by doing' that is common in studio-based architectural teaching (quoted in Schon 1985: Foreword). This cross-disciplinary approach is echoed by Wilson (1997) who writes about the development of a 'Studio Model' for a variety of courses at the Rensselaer Polytechnic Institute in New York. First introduced as a model to cope with large enrolment on undergraduate courses in Maths and Physics, the Studio Model '...has since been adapted to Chemistry, Biology, Engineering and Computer Science.' At the same time, a Kansas State University undergraduate biology course demonstrated 'that the studio format is as effective as or more effective (for some measures) than the A-T approach and traditional approaches in providing an effective learning environment' (Montelone et al 1997).

More recently, Foulds et al (2003) see studio learning in bio-medical engineering 'as an alternative to the conventional lecture/ recitation/laboratory format, and it is shown to encourage student inquiry and foster faculty and peer mentoring.' Further, Barak describes how a shift in teaching and learning practices in delivery of a java programming course 'to collaborative studio- based learning, via mobile devices, may be an important trend in the way learning is perceived and knowledge is constructed' (2007:27).

However, as both Hatton's conference proceedings and the Design Research Society can attest, educational research in design is taking place, and indeed the latter has seen the coming into being of the Design Pedagogy Special Interest Group. This perhaps reflects the recognition that since the 1990s there has been a 'growing awareness' of the importance of the designer within a global environment and how design pedagogy 'may prepare the undergraduate and postgraduate student for global and sustainable design development.' (Hatton 2008: viii) In this vein, the author believes that using the threshold concept framework within the industrial design programme at Coventry University has added to the educational research data available.

Consequences

Given that creative arts courses are generally very good at producing creative graduates, does it really matter that there is a lack of published materials relating to teaching and learning practice within higher education? This question is all the more pertinent, given that the recent REF guidelines privilege research that has an impact OUTSIDE the academy:

> *Case studies may include any social, economic or cultural impact or benefit beyond academia* that has*

> *taken place during the assessment period, and was underpinned by excellent research produced by the submitting institution within a given timeframe.(HEFCE 2011).*

Therefore, if creative arts courses are successful and educational research is not being given a particularly high rating in research terms in the REF, it is the case that the expenditure of effort and resources will be disproportionate to the level of reward?

This author argues that the consequences of not having a firm baseline of published educational research in this area has left creative arts disciplines as whole undefended against government cuts, and in turn undefended against the internal pressures within the institutions within which they sit. This is echoed by Shreeve who stated in 2009 that:

> *If we do not articulate and develop awareness and knowledge based on research we are unlikely to be able to defend our beliefs about art and design education in the university in the light of the growing demands for uniformity and conformity, usually originating in sectors outside our own disciplinary context. How are we to argue for what we believe and develop learning in creative arts if we do not base our arguments on sound research and enquiry methods? (2009:128)*

Writing in 2011, the lack of defence is evidenced by the UK Comprehensive Spending Review in October 2010, which demonstrated, at the very least, that the government does not see the humanities, within which most creative arts courses fall, as crucial to the country's success. The Review cut the teaching grant for Band D subjects by 100%, but is to 'continue to fund teaching for science, technology, engineering and mathematics (STEM) subjects.' At the same time, George Osborne, the Chancellor of the Exchequer announced that 'scientific research was being protected because it was 'vital to our future economic success'. (Morgan 2010)

This dismissal of humanities as not being as important as STEM subjects is possibly because the government cannot easily measure their impact as, according to Eyre '...they're wayward and ambiguous and because they deal with feelings rather than facts.' (2011). This is reflected by Ransome in terms of the differing teaching styles within Higher Education: either academic 'the abstract and esoteric process in which knowledge is problematised as a social construction (broadly the arts, humanities and social sciences)' or instrumental '...those that instruct students in a body of technical information generally oriented towards clear practical application (broadly the natural and

physical sciences and disciplines characterised by technical knowledge)' (2011: 209)

The new regime will see the teaching budget for the humanities funded by (higher) fees, and thus each course will be funded by students, who either pay the fees themselves, or through student loans. This means that humanities courses from 2012 will now be dependent on the ability to 'persuade students to pay £7000 to £8000 a year, a task that may be beyond many of them.' (Cohen 2011) The question is whether the worthiness of humanities subjects is going to be negatively affected by the disdain that the government has shown towards those very subjects, epiomised by a another quote from Cohen, 'It tells you all you need to know about the political class's commitment to culture that the Department for Business rather than the Department for Education is in charge of universities.' (IBID)

There is some hope that students will choose humanities subjects as figures from the Higher Education Statistics Agency show that EU student figures climbed to 40% and non EU figures to 78% in these subjects between 2001-2010 (Roberts 2011). However, this hope may lose currency if students choose courses that are going to result in perceived higher pay upon graduation. It is probable that being an artist, or a designer, in a world where these occupations are seen as not only NOT essential to the economy, but as actually an 'add-on' soft subject, could see creative arts courses going to the back of the desirable course queue.

In terms of internal pressures, this need to self-fund courses will also have a knock-on effect on the internal market within universities which manifests itself as in a culture of 'new managerialism' defined by Deem as:

> *...the use of internal cost centres, the fostering of competition between employees, the marketisation of public sector services and the monitoring of efficiency and effectiveness through measurement of outcomes and individual staff performances. (1998:50)*

In this culture, university management is obviously going to make decisions based on how much money courses can attract, and those decisions will be based on how measurable the outcomes of courses are. Therefore it is essential that creative arts disciplines continue to research their teaching and learning practices and make explicit the benefits of such an educational route.

As mentioned earlier this is not straightforward as they can resist easy measurement and this problem is epistomised by a paper written by Cowdroy and Willams (2006) from the University of Newcastle in Australia. In the paper the authors outline the process a creative design course had to undertake in response to a student appeal against a 'fail' mark for a particular module. This appeal brought the course to the attention of the university

hierarchy who subsequently demanded that the course be re-written with outcomes that clearly distinguished between a pass and a fail, instead of being based 'largely on established best practice'; without a defined criteria for creative ability.

Acknowledging that the current assessment criteria was based on tacit knowledge - 'what the teachers liked' – and was therefore difficult to explain to students, the course team went on retreat and consulted the literature in order to define what they meant by creativity, how this linked the concept of an 'ideal graduate' and then examined how to integrate both into desired curriculum outcomes. Using the literature, the team consulted across the faculty and undertook a root and branch consideration of notions of creativity in order to assess how these fitted into design education, how they could be taught and how they could be explained in order to satisfy the quality assurance agenda. The conclusion was that as a result of this process, the rewritten course satisfied three particular stakeholder pressure points: from external reviewers by adding new relevant content, from the university by increasing cost effectiveness including adopting the use of more lectures and online courses, and from government in terms of accountability by adopting clearly defined and appropriate assessment methods.

Conclusion

Despite the current government rhetoric which privileges the sciences over humanities, it is acknowledged everywhere (apart from the government departments which make the funding decisions, is seems) that competitive advantage is strengthened by creative input as outlined by Peattie:

> *Sustainable competitive advantage is very rarely generated from technological excellence alone. Today, in markets which many people might assume to be dominated by technological issues, including cars, home computers and mobile phones, it is actually 'soft and subjective' factors like design, branding or customer service that are ultimately crucial in delivering and sustaining competitive advantage. These factors are very strongly rooted in the arts, humanities and social sciences. (quoted in British Academy 2010: 19)*

As this paper has discussed, this message is not getting across to the policymakers and the argument this author is developing is that one of the reasons for this is that creative arts disciplines are not encouraged and supported in publishing enough good quality educational research about teaching and learning practices. Thus the link between the plethora of creative and critically minded practitioners who graduate from creative arts

courses and the teaching and learning practices that facilitated this is not made clear enough.

Further, the lack of published material is historically due to a vocational sensibility developed when creative arts disciplined were 'outside' the academy coupled with an ever-shifting domain knowledgebase. This has resulted in an established educational research culture not being fully supported within institutions and as a consequence creative arts staff can be somewhat unused to writing about their teaching and learning practices in a scholarly way.

Therefore, this author argues that without initiatives such as the CETL, which enabled the Coventry University research, groups such as the Group for Learning in Art and Design (GLAD), the International Council of Graphic Design Associations (Icograda), the European League of Institutes of the Arts (ELIA), and, of course, the Design Research Society (DRS) are crucial in bringing together educational researchers within the creative arts. These groups have a vital role in encouraging and showcasing research on teaching and learning practices within what could be considered 'wicked disciplines' in that they, like the 'wicked problems' they privilege, contain Gordon's (2004: 61) 'wow' factor: 'creativity, originality, inventiveness...' and, as such, resist easy categorisation or definition.

That these research papers will be in narrative rather than scientific is something that the Professor Sir Adam Roberts, President of the British Academy commented upon:

> *There is no simple way of demonstrating the subtle and unexpected ways in which academic disciplines "contribute to the vitality of society". Research and teaching often has effects in ways which may be captured in narratives as much as in statistics. (British Academy 2010: 5)*

Given that the world is full of what Schon (1985: 15) calls 'real world problems' that are 'messy, indeterminate, problematic', or indeed wicked', the need to build up a viable, solid body of educational research that can be used to defend creative arts disciplines against attack - and also to demonstrate the importance of creativity in underpinning a vibrant, critically minded society that does not depend on a science/humanities divide - is as important now as it ever was if 'wicked disciplines' are to survive.

References

Alias, M., Black, T., Gray, D. (2002) 'Effects of Instructions on Spatial Visualisation ability in Civil Engineering Students.' in *International Education Journal* Vol. 3, No. 1

Barak, M. (2007) 'Studio-based learning via wireless notebooks: a case of a Java programming course'. Int. J. Mobile Learning and Organisation, Vol. 1, No. 1,.

Bird, E. (2000) Research in Art and Design: the first decade. *Working Papers in Art and Design* 1, Retrieved < 26.3.11 > from < http://sitem.herts.ac.uk/artdes_research/papers/wpades/vol1/bird2full.html > ISSN 1466-4917

British Academy (2010) *Past, present, and future the public value of the humanities & social sciences.* Available*:* http://www.britac.ac.uk/policy/pastpresentandfuture.cfm, [Accessed 22.3.11)

Bodner, G. and Guay, R. (1997) 'The Purdue Visualisation of Rotations Test'. *The Chemical Educator*, 2(4): 1-17.

Buchanan, R. (2001) Design Research and the New Learning'. *Design Issues*. V17.4.

Cohen, N. (2011) 'Academia plays into the hands of the right'. *The Guardian*. Available: http://www.guardian.co.uk/commentisfree/2011/jan/30/nick-cohen-higher-education-cuts

30 January. [Accessed 23.3.11]

Cowdroy, R., Williams, A. (2006) 'Assessing creativity in the creative arts' in *Art, Design & Communication in Higher Education.* V5, N2. Intellect Ltd 2006

Cross, N. (2006) *Designerly Ways of Knowing*. Springer-Verlag. London

Deem, R. (1998) 'New Managerialism' and Higher Education: the management of performances and cultures in universities in the United Kingdom' in *International Studies in Sociology of Education*, Vol. 8, No. 1.

Doy, G. (2008) "Let's all go shoplifting: Culture, Consumerism and Education' in Hatton, K. ed. (2008) *Design Pedagogy Research*. Leeds

Eliot, J. (2002) 'About Spatial Intelligence'. *Perceptual and Motor Skills*, 94, 479-186.

Eyre, R. (2011) 'Arts cuts will result in cultural apartheid' *The Guardian*. Available: http://www.guardian.co.uk/culture/culture-cuts-blog/2011/feb/15/arts-funding-arts-policy [Accessed 26.3.11]

Foulds, R., Bergen, M., Mantilla, B. (2003) Integrated biomedical engineering education using studio-based learning.' Engineering in Medicine and Biology Magazine, IEEE Volume: 22 Issue: 4. 92 - 100

Garg, A., Norman, G., Spero, L., Taylor, I. (1999) 'Learning anatomy: do new computer models improve spatial understanding?' in *Medical Teacher*, Vol. 21, No. 5

Gardner, H. (1983) *Frames of mind: the theory of multiple intelligences*. New York: Basic Books

Shearer, B. (2004) 'Multiple Intelligences Theory after 20 Years.' in *Teachers College Record*. Vol. 106, no. 1 pp2-16

Hatton, K. ed. (2008) *Design Pedagogy Research*. Leeds.

HEFCE (2011) *Decisions on assessing research impact*. Available http://www.hefce.ac.uk/research/ref/pubs/2011/01_11/ [Acessed 22.3.11]

Joseph, F. (2008) 'Design Research and Domain Representation' Proceedings of *DRS2008, Design Research Society Biennial Conference*. Sheffield, UK. 16-19 July

Karnath, H., Ferber, S., and Himmelbach, M. (2001). 'Spatial awareness is a function of the temporal not the posterior parietal lobe.' *Nature*, Volume 411(6840): pages 950-953

Meyer, R. Land & C. Baillie, eds (2010). *Threshold Concepts and Transformational Learning*. Sense Publishers. Rotterdam.

Montelone, B., Rintoul, D., and Williams, L. (2008) *Assessment of the Effectiveness of the Studio Format in Introductory Undergraduate Biology.* CBE Life Sci Educ 2008: 234–242. Availbel online http://www.lifescied.org/cgi/content/full/7/2/234. Accessed 27.4.11

Morgan, J. (2010) 'Fears made flesh: only STEM teaching grants spared CSR scythe'. *THES*. 20 October. Available: http://www.timeshighereducation.co.uk/story.asp?storycode=413956 [Accessed 24.3.11]

Osmond, J., Turner A. (2010) 'The Threshold Concept Journey: from identification to application'. In JHF Meyer, R. Land & C. Baillie, eds. Threshold Concepts and Transformational Learning. Sense Publishers. Rotterdam.

Osmond, J., Bull, K., Tovey, M. (2010) Threshold concepts and the transport and product design curriculum: reports of research in progress. In *Art, Design and Communication in Higher Education*. Special edition 8.3

Osmond, J. (2009) 'Stuck in the Bubble': Identifying Threshold Concepts in Design' in *Dialogues in Art and Design: Promoting and Sharing Excellence, Proceedings of the 2009 GLAD Conference*, held at York St John University, York. ADM

Osmond, J. and Turner, A. (2008), 'Measuring the creative baseline in transport design education', In Rust, C (ed) *Improving Student Learning – For What? Proceedings of the 2007 15th International Symposium*, Trinity College, Dublin. p.87-101. The Oxford Centre for staff and learning development. Oxford Brookes University. Oxford.

Osmond, J., Turner, A. & Land, R. (2008) 'Threshold Concepts and Spatial Awareness in Automotive Design.' In Land, R., and Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam

Perkins, D. (2006) Constructivism and Troublesome Knowledge in Meyer, J.H.F. and Land R. (Eds.) *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. London and New York: Routledge. pp 33-47.

Poggenhol, S. (2004) 'Language definition and its role in developing design discourse'. *Design Studies*. 25.6. November.. p. 579-606

Ransome, P. (2011) 'Qualitative Pedagogy versus Instrumentalism: the Antinomies of Higher Education Learning and Teaching in the United Kingdom'. *Higher Education Quarterly*, Volume 65, No. 2, April 2011, pp 206–223. 0951–5224 DOI: 10.1111/j.1468-2273.2010.00478.x

Ritterman, J. (2010) 'Riding the Tiger: Leading institutions for higher education and the arts at the beginning of the twenty-first century' in Corcoran, K., Delfos, C, Solleveld, F. (eds) (2010) *ArtFutures Current issues in higher arts education*. Amsterdam. December. Available: http://www.elia-artschools.org/News%2B/ArtFutures+-+Current+issues+in+higher+arts+education. [Accessed 28.3.11]

Roberts, A. (2011) 'The end is not nigh.' *The Guardian*. Available: http://www.timeshighereducation.co.uk/story.asp?storycode=415349 [accessed 22.3.11)

Schon, D. (1985) *The Design Studio An Exploration of its Traditions and Potentials.* RIBA Publications. London

Shearer, B. (2004) 'Multiple Intelligences Theory after 20 Years.' in *Teachers College Record*. Vol. 106, no. 1 pp2-16

Sonalkar, N. (2008) 'Interview with Nigel Cross'. *Ambidextrous*, Issue 9. Spring.

Shreeve, A. (2009) 'Why bother with research in Learning and Teaching in Art and Design?' in *Dialogues in Art and Design: Promoting and Sharing Excellence, Proceedings of the 2009 GLAD Conference*, held at York St John University, York. ADM

Temple. C., Carney, R. (1995) 'Patterns of spatial functioning in Turner's syndrome.' *Cortex*. 31(1):109-18.

Tovey, M. (2011) 'Researching Design Education'. Keynote for *CUMULUS DRG SIG on Design Pedagogy. 1st International Symposium for Design Education Researchers*. Paris 18-19 May.

Tovey, M., Bull, K., Osmond, J. (2010) 'Developing a Pedagogic Framework for Product and Automotive Design'. *Design & Complexity Conference*. Université de Montréal. July

Tovey, M. (1984) 'Designing with both halves of the brain' in *Design Studies*, Volume 5, Number 4. October. pp 219-228. Elsevier.

Wilson, J. (1997) *'Studio Teaching: When the Future Becomes the Present'.* UniServe Science News Volume 7 July 1997. Available online: http://sydney.edu.au/science/uniserve_science/newsletter/vol7/wilson.html. Accessed 26.4.11)

Submission [8]

Osmond, J. (2012) 'Passports to a community of practice' in *Design for Transport*. Ed. Tovey, M. UK: Gower, 335-352

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The scholarship of teaching: threshold concepts and research informed design education

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Abstract: *This paper considers the growing body of established scholarly research culture in the creative arts: which, it is argued, is in the process of 'catching up' with more established disciplines such as science, history and economics. This slow growth is linked to the need for practitioner-focused lecturers within the discipline, some of whom have little engagement with scholarly theory before entering the academy. The paper then goes onto consider the introduction of a particular theory - the threshold concept framework - to a cohort of industrial design staff at Coventry University and outlines some of the main impacts on both their continuing professional development and their teaching and learning practices. Specifically the main impacts have been an embedding of a threshold concept 'lens' through which the lecturers interviewed now see their teaching and learning practice, which has resulted in both changes in curriculum delivery, and an enhancement of publishing profiles.*

Keywords*: Research, design education, design curriculum*

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Introduction

With its historically firm focus on practitioner expertise, scholarly research cultures within creative arts disciplines are not as well established when compared to more traditional subjects such as science, history and economics. This is reflected by the UK Research Exercise Framework (REF). When referring to the Art and Design unit of assessment (HEFCE 2012) the criteria acknowledges "the diversity and range of related methods of academic study and artistic practice, and therefore adopts an inclusive definition of its remit". This is coupled with a focus on practice: "Practice encompasses all disciplines within art and design, in which methods of making, representation, interrogation and interpretation are integral to their productions".

This recognises that creative arts practitioners are typically, first and foremost, employed for their creative, rather than scholarly writing, expertise.

This often means that staff are unfamiliar with scholarly writing and publishing processes, and in turn do not readily engage with theories which they can apply to their teaching and learning practices.

This paper discusses the impact of introducing one particular theory - the threshold concept framework - to industrial design staff as part of a longitudinal study carried out by the Centre for Product and Automotive Design (CEPAD) at Coventry University between 2005 and 2010.

CEPAD was funded as part of the HEFCE CETL[*] initiative, and as a result of the longitudinal study, *the toleration of design uncertainty* emerged as a first-year threshold concept, defined as "the moment when a student recognises that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process". (Tovey et al, 2010)

As a result, the industrial design undergraduate curriculum was redesigned in order to offer safe spaces to students within which they could experience the intense uncertainty that is characteristic of the design process. This was facilitated by a re-thinking of the assessment process, which 'loaded' the marks towards the end of the academic year, allowing the students the opportunity to not worry about the marks, and thus learn from this, at the beginning of the year. (IBID)

As well as having an impact on the curriculum, the threshold concept theory also had an impact on the staff of the industrial design department, in that it allowed them to discuss and share their subject expertise with each other, and, for some, to view their subjects through a 'threshold concept lens'. This facilitated adjustments to teaching and learning practices and subsequently - through enhancing research profiles - impacted on continuing professional development.

This paper picks out several, previously unpublished, key points outlining the impact of linking theory to teaching practice, through focusing on four particular members of staff who have published papers using the threshold concept theory.

Creative arts staff and research culture

As has been argued elsewhere (Osmond 2011), there is a paucity of published educational research into the teaching and learning that underpins teaching within creative arts disciplines. The reasons for this are linked to the lack of established

[*] http://www.hefce.ac.uk/whatwedo/lt/enh/cetl/

research culture surrounding the creative arts, which historically were taught within independent art schools or, pre 1991 in the UK, in polytechnics (Bird 2000).

As such, the focus has always been on the practical in terms of employing creative arts staff who are practitioners first and foremost, rather than scholarly academics. Therefore, being practitioners, creative arts staff are - in comparison to more established disciplines such as science, history, and economics - much more likely to bring with them expertise in their *craft*, whether joining from a creative arts educational background, or from industry, rather than scholarly writing expertise.

This lack of scholarly writing expertise is compounded by a debate as to what exactly constitutes scholarly writing: as MacFarland (2011), bitingly suggests, it is to everyone's detriment that there is a division between scholarly research and pedagogic research:

> Subject-based research is serious, scholarly and well-respected stuff. It is published in prestigious subject-based journals. This kind of research is what counts in the assessment of research quality in countries like the UK, Australia and New Zealand. Then there is 'pedagogic' research. This is where academics from various disciplines do research about their own teaching, that of others or focus on the way students learn…But apparently, unlike subject-based research, 'pedagogic' research is not 'proper' research. It is not, therefore, any good for the purposes of research assessment.'

Further, this lack of a widely agreed framework for 'proper' research, especially within the creative arts, perhaps reflects its status as an "ill structured and undisciplined domain" (Joseph 2008) which privileges "wicked problems" (Buchanan 1992) at its heart, underpinned by teaching practices based on tacit knowledge.

There is too, within the creative arts, a suspicion that research itself may well kill the golden goose – in other words, that researching creativity will somehow dispel its 'magic'. (Doy 2008, Ritterman 2010)

The Centre of Excellence and Product Design

It was into this backdrop that the Centre of Excellence for Product and Automotive Design (CEPAD) first introduced the notion of threshold concepts as a research framework to industrial design staff in 2005. Threshold concepts are defined by Meyer and Land as:

> akin to a portal, opening up a new and previously inaccessible way of thinking about something [representing] a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (2003:1)

The aim of the research was to pinpoint those crucial transformative moments that industrial design students must experience in order to become critically minded, innovative practitioners.

Staff and threshold concepts

However the focus of this paper is the impact that the threshold concept theory had on particular members of staff in terms of their teaching and learning practices and continuing professional development.

The staff were involved in the longitudinal study from the very beginning, starting with attendance at a whole-staff meeting in early 2006. The outcomes from this are detailed in Osmond et al (2007), but in essence the meeting was characterised by staff enthusiasm to share knowledge about their subject. The initial discussion focused on the definition of 'spatial awareness' as this was seen as a crucial ability by staff for the students on the course, but despite extensive discussion it was not possible to define this and thus it was also not possible consider whether it could be a threshold concept. Despite this, several potential threshold concepts were identified, one of which – 'the confidence to challenge' (defined as the ability to inculcate design conventions and expand upon them using information from a variety of sources and experiences) was taken forward for investigation with students.

This meeting represented the beginnings of staff involvement with the threshold concept theory, and at a later meeting in March 2008, they were presented with the findings from the longitudinal study to date, which included data from student interviews showing that there was a level of uncertainty in terms of the 'confidence to challenge' being expressed. Again this meeting was characterised by a lively discussion of potential threshold concepts that students face throughout the course, including the notion of empathy (not just designing for themselves), professional development (increased confidence on return after work placement), and group work (allowing someone else's design to go forward). (Osmond et al 2010). What was apparent at this meeting was that the staff were now routinely engaging in framing student breakthrough moments in terms of threshold concepts.

This engagement by staff is reflected by Irvine and Carmichael (2009) who took part in a similar meeting:

> It is worth stating from the outset that we were pleasantly surprised by the extent to which the participants were willing to critically review their existing practice…these are accounts of concerned, reflective practitioners engaging with educational theory and practice in distinctive ways.

This level of engagement has continued with particular members of the original staff group and four lecturers were interviewed in late 2011 to identify the impact of the threshold concept theory both in terms of their teaching and learning practices and their continuing professional development.

Major Impacts

Framing understanding of the learning process

A major impact for most of the lecturers interviewed was that using the threshold concept theory allowed them to intellectually frame their understanding of the student learning process, with one lecturer linking the threshold concept framework with the notion of bricolage to produce a coalescence of understanding:

> For me conceptual thresholds are a little bit like bricolage in the sense that there are many of them and depending on the individual they may be different, so you can't teach to a formula because people have to discover what threshold concepts are relevant to their own learning. The collage that it creates will be very different depending on the individual.

For two of the lecturers, the theory enabled an articulation of what they instinctively 'knew':

> Before I wouldn't have put a title on it – you can tell when a student has achieved a certain level of ability or a certain way of critical thinking and at the time it would be just part and parcel of that student learning how to be a designer. I think having the framework is putting a title on some of the things that they are actually doing.

> You can happen across [threshold concepts] all the time and they seem to occur to different students at different times… I think you can see it in the level of confidence that they have.

Another lecturer also experienced a threshold concept moment of his own during his recently completed MA degree:

> I started to develop more of an interest in teaching design to students during [my MA] because when you are on the receiving end of it you think differently and you understand how long it takes to do things that you are asking the students to do.

The lecturers also began to identify threshold concepts, for example reflective sketchbooks were problematic for some students "because they can't deal with that whole idea of looking back". Also interesting were student difficulties with the difference between rendering and a piece of art:

> Trying to get the student to understand the difference –any good designer will tell you that they will spend three hours on a rendering and if they don't like it, it is screwed up and thrown in the bin. You often see the shock on [the students'] faces, but they need to realise that it is just a communication tool, it is not precious like the Mona Lisa!

This was an issue that had emerged during the longitudinal study, where students reported wasting hours on trying to produce a perfect render in their first year, but progressed to a much quicker sketch by the end of their second year.

Empathy

The recognition of threshold concept moments led to a more empathetic mode of teaching for one lecturer:

> In the past I would probably have thought 'oh this student probably just isn't a good designer' or 'they are just not getting it/don't draw very well'. I don't think that is true now: understanding that they will go through gateways at different levels helps you to have more empathy towards them and help them to play to their strengths. I think for me that is probably the most important.

This is echoed by Dewey, who, as far back as 1963, proposed that "The key element which facilitates the transition from a good education to a transformative one is empathy." Further, Ramsden (1992) suggests that interest in and empathy for students are necessary components of good teaching.

In addition, the notion of empathy as a threshold concept led to one lecturer to make the connection between design empathy and the concept of the 'other' (after Said 1991), taken from cultural studies. This link was used to present students with the concept of the 'other' during an ergonomics module with first year students which also used personas to encourage them to think 'outside themselves' (Osmond & Mackie

2012). This is felt to be important for design students as, typically, when they arrive, they tend to want to design for themselves, and the concept of identifying with someone who is 'not them', is a difficult phase in their design identity development process. As this lecturer states:

> When they can think like an old lady trying get a bag onto a bus I think that is the breakthrough moment when they can achieve interesting design because it is that ability to think outside [of themselves]

This empathetic recognition of the different journeys that students undertake in their learning process is seen as student-centred teaching, a threshold concept in itself according to Blackie *et al* (2010):

> …we suggest that student-centred teaching is a threshold concept [and it] is not just a different style of teaching. It requires that the academic really understands and appreciates the need to pay attention to the students and their learning. It involves a shift from measuring one's success as a teacher by how much of the syllabus is successfully covered to measuring one's success by how much the students actually learn and with what depth of understanding.

Changing teaching practices

For two of the lecturers the identification of specific threshold concepts led towards a change in teaching practice. A Year 2 lecturer found that students were unused to defending their research process due to a focus on the formulaic 'presentation mode of assessment' typified by the standard 'pin up and leave' crit. This method of assessment meant that students did not need to defend their designs and thus demonstrate the journey from research to designed artefact.

> It is where they pass through this threshold as well - the idea that research is not just something where you do nice slides and put it on screen, and then do something completely different.

Meanwhile, for an MA lecturer, there was the recognition that some students had difficulty in thinking creatively when formulating their research proposal:

> I went through a systematic step-by-step delivery each week and at the end they got a mark and they were unhappy because they felt that 'I did everything you told me to do so I should understand, I should get it why have I not got 95%'. So clearly the threshold concept had not manifested itself in that module.

Both lecturers changed their teaching practices as a result. The Year 2 lecturer redesigned the assessment method for a year-long module. In essence, the assessment method – entitled the 'buddy system' (Osmond and Clough 2012) – is now much more closely aligned to the crits found in industry.

The focus is now extensively on the feedback element of the crit, rather than the final mark, and ensures that during each assessment session, the students are expected to demonstrate the link between their research and their final design by entering into a dialogue about their thinking processes. The lecturers, freed from taking notes by a system of student note-takers, can maintain eye contact and walk around the design: in other words, the lecturer and student enter into a professional dialogue about the work. Due to this change, the student focus on the 'mark' has lessened:

> Students are suddenly saying that the mark is less important now, because they are realising you know when something is a good piece of design - the whole thing is far far greater than the sum of the individual boxes you are ticking.

In the meantime, the MA lecturer moved towards a teaching model that emphasised conceptual thinking, rather than a linear step-by-step process (Bull 2013). Early indications are that the students are beginning to make connections between different ideas much more quickly and some have begun to experiment with this.

This change of focus which takes student understanding as the impetus to redesign teaching practice, is recognised by McLean (2009):

> Threshold concepts provide a lens through which teachers can view teaching in their discipline from a different perspective and, along with this, consider areas where their students 'get stuck' and why – areas that may emerge as threshold concepts… clarifying 'what' it is that students should learn and why it is important, where they effectively shift the focus from teaching to learning and from content to understanding.

Research profiles

Another big impact of the threshold concept theory has been on individual research profiles, with all the lecturers interviewed writing up pedagogic research framed by the theory for publication. Using the threshold concept to frame their research, carry it out, write it up and submit it for publication gave these lecturers the knowledge, skills and confidence to continue to publish. As one lecturer stated: "Threshold concepts allows people to write about their teaching and the theory allows it to be taken seriously".

For these lecturers – practitioners all – this change is important as previously engaging with theory and pedagogic research was felt to difficult enough due to the time pressures of teaching, and was, at best, perhaps perceived as just another 'demand' something echoed by D'Andrea *et al* (2000).

Also, engaging with the publication process was previously felt to be daunting, with one lecturer stating that he 'didn't see pedagogic research as being research for me' and another feeling that she was expected to 'simply know' how to research and publish: not only this, but also to demonstrate that she had done so in yearly appraisals. This hesitancy resonates in Stierer and Antoniou's work, when they found that HE lecturers often felt hesitant in carrying out pedagogic research as 'they lack confidence in their skills to cross-disciplinary boundaries and come out of their disciplinary comfort zone'. (Quoted in Brewer *et al* 2011) In addition, D'Andrea *et al* posit that those who *are* interested in pedagogic research can sometimes be isolated within their own department as 'the member of staff interested'.

To date then, three of the lecturers have inculcated the theory into their teaching and learning practices and have subsequently raised their research profile through publication. This focus on theory has continued with a newly appointed lecturer, arriving directly from industry, already on board with the theory, "recognising in his teaching that there are these kind of moments". This willingness to engage by a new lecturer is perhaps a reflection of a changing culture in which lecturers within the department are beginning to feel more comfortable in thinking about their teaching and learning practices in terms of theory. Therefore, in contrast to D'Andrea *et al*'s 'only member of staff interested', this engagement by a newly arrived lecturer signifies

that he is being brought into an existing culture of expectation in relation to pedagogic research, and thus evidencing an overall shift in departmental thinking.

To date, only one of the lecturers interviewed has not taken the theory fully on board, and this could be because, unlike the other three, she was not present at either the introductory session in 2006 or the follow-up in 2008. This appears to point to the importance of being part of the initial exchange of views, or the sharing that characterised both sessions, something that Skelton and Wisker comment upon:

> Striving for pedagogic excellence should be about learning and teaching development; sharing practice; promoting staff equality; and reuniting the separated research and teaching identities (Skelton, 2009; Wisker et al 2005: quoted in Skelton 2009).

Concerns

As outlined earlier in this paper, one of the immediate impacts of the presentation of the threshold concept theory to staff at two points during the longitudinal research process was how enthusiastic the staff were in talking about their subjects.

However there were concerns expressed about how to 'really' identify threshold concepts. As one lecturer stated, "everyone has a slightly different interpretation of what [a threshold concept] might be", and another was uncertain about "how accessible portals and thresholds are". This uncertainty is common in relation to threshold concepts, as the five characteristics defined by Meyer and Land are often seen as definitive. Therefore if a potential threshold concept does not fit all five characteristics, people sometimes struggle with identification:

> I am not sure about how much conviction or justification you would need to provide something that is justifiably a threshold concept - it is quite subjective in the sense of what is in and what is out - it feels like you can make a case for it but not necessarily one that I am 100% convinced about in my own mind.

But as Irvine and Carmichael point out, threshold concepts are "better thought of as pointers or framing devices or as evidence of their 'value-for-use' rather than as defining characteristics", or, for Meyer and Land as "ways of thinking and practising in a discipline".

Added to this uncertainty is the criticism that threshold concepts are 'just another theory': as one lecturer put it: "it feels like it is one of those things that I have come across: different theories that are descriptive but are not terribly useful in telling you what to do"

This is something that Glynis Cousin tackles in her keynote address at the *Threshold Concepts within the Disciplines Symposium* in 2006. Entitled 'Old Wine in New Bottles', Cousin acknowledges that the threshold concept framework can be seen as just another theory, but for her its importance is that it allows what she calls "transactional enquiry". In essence this is a move away from a teacher-centred/student-centred traditional binary opposition and towards a constructive, constantly shifting dialogue, between lecturers and students.

This is reflected by three of the lecturers, who despite their concerns, are still engaged with the threshold concept theory and continue to think about their teaching and learning practices through a threshold lens, constantly questioning and re-framing their understanding, whilst at the same time interacting and engaging with their students in order to improve their educational experience.

Conclusion

This paper has considered a lack of established scholarly research culture in the creative arts, which, it is argued, is linked to traditional practitioner-focused lecturers, some of whom have little engagement with scholarly theory before entering the academy.

The paper then goes onto consider the introduction of the threshold concept framework theory to a cohort of industrial design staff at Coventry University and outlines some of the main impacts on both their teaching and learning practices and continuing professional development.

Specifically the main impacts have been an embedding of a threshold concept 'lens' through which the lecturers interviewed see their teaching and learning practice: even though there were concerns expressed over precise understandings of the threshold concept theory, three of the lecturers are still iteratively engaging, thinking and pursuing their knowledge in this area. Other impacts were the subsequent development of a more empathetic teaching approach leading to changes in curriculum delivery, and the enhancement of individual research profiles.

This willingness to engage in theory was kick-started by CEPAD, which came into being as result of the HEFCE CETL initiative. That CEPAD has survived beyond the HEFCE funding stream (which ended in 2010), and that newly appointed lecturers are now buying into an expectation of pedagogic research, is a testament to Coventry University's willingness to perpetuate the nascent research culture that expanded during the five years of the project. As a result, two roles were subsequently consolidated – the Directorship of CEPAD and Director of Design pedagogy. More recent appointments include a research-active Dean, and a professor of design research. Therefore, there is a clear indication that such funding streams have a great deal to offer universities in this area.

As it is, the legacy of CEPAD is that it is constantly adding to the growing research culture within the creative arts, underpinned by publications such as *The Design Journal, Design Studies* and the *International Journal of Design*; the presence of the Design Research Society (DRS) and its bi-annual conference, and the (also bi-annual) DRS Cumulus conference which focuses exclusively on design pedagogy. This coupled with the recognition within the REF that practiced-based artefacts are as valuable as scholarly outputs, indicates that the creative arts are finally beginning to establish a research culture of its own.

References

Bird, E. (2000) "Research in Art and Design: the first decade". *Working Papers in Art and Design* **1.** [Cited 29 October] Available from: http://sitem.herts.ac.uk/artdes_research/papers/wpades/vol1/bird2full.html

Blackie, M., Case, J., Jawitz, J (2010) "Student-Centredness: the link between transforming students and transforming ourselves". *Teaching in Higher Education*. Vol. 15. No. 6. December. Routledge.

Brewer, G., Dennison, D., Hewertson, J., Pilkington, R., Smith, R., Smith S., Wood, G. (2011) "IMPACT Linking Teaching & Research: Pedagogic Research". [Cited 8 January 2013] Available online: http://www.academia.edu/1969990/IMPACT-_Pedagogic_Research

Buchanan, R. (1992) "Wicked Problems in Design Thinking." *Design Issues*. Spring. V8 No2

Bull, K., and Osmond, J. (2013) "Design Education and non-EU students: shifts in teaching practice"*DRS // CUMULUS Oslo 2013: The 2nd International Conference for Design Education Researchers*. May 14-17, Oslo, Norway

Cousin, G. (2007) "Threshold concepts: old wine in new bottles". In Land, R., Meyer, J. and Smith, J. (eds) *Threshold concepts in the disciplines.* Rotterdam: Sense Publishers.

D'Andrea , V., Gosling, D., (2000) "Promoting Research in Teaching and Learning in Higher Education: two case studies of multi-disciplinary pedagogic research". *ESRC Teaching and Learning Research Programme, First Annual Conference.* November. [Cited 8 January 2013] Available online: http://www.leeds.ac.uk/educol/documents/00003207.htm

Dewey, J. (1963) *Experience and education*. New York: Collier Books

Doy, G. (2008) "Let's all go shoplifting: Culture, Consumerism and Education" in Hatton, K. ed. (2008) *Design Pedagogy Research*. Leeds

HEFCE (2012) "Panel 2D: Main Panel D criteria". [Cited 29 October) Available online: http://www.ref.ac.uk/pubs/2012-01/

Jones, J. (2010). "Building pedagogic excellence: learning and teaching fellowships within communities of practice at the University of Brighton". *Innovations in Education and Teaching International*. Vol. 47, No. 3, 271–282

Irvine, N., Carmichael, P. (2009) "Threshold concepts: A point of focus for practitioner research". *Active Learning in Higher Education*. 10.103

Macfarlane, B. (2011) "Prizes, pedagogic research and teaching professors: lowering the status of teaching and learning through bifurcation". *Teaching in Higher Education*. Vol. 16, No. 1, February 2011, 127-130

Meyer, J., and Land, R. (2003) "Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines". In C. Rust (Ed.) *Improving Student Learning Theory and Practice - 10 years on,* OCSLD, Oxford.

Osmond, J. (2011) "A 'Wicked' problem for a 'Wicked' Discipline". *Researching Design Education: 1st International Symposium for Design Education Researchers. CUMULUS // DRS 2011. Paris Symposium*. 18-19 May

Osmond, J., Clough B., (2012) "Assessing Design through Assessment Buddies". *DRS 2012*, Bangkok. 1-4 July

Osmond J., Mackie, E. (2012) "Designing for the 'Other'". *DRS 2012*, Bangkok. 1-4 July

Osmond, J., Turner A. (2010) "The Threshold Concept Journey: from identification to application'" In JHF Meyer, R. Land & C. Baillie, eds. *Threshold Concepts and Transformational Learning.* Sense Publishers. Rotterdam.

Osmond, J., Turner, A. (2008) "Measuring the creative baseline in transport design education". In Rust., C. (ed) *Improving Student Learning – For What?* OCSLD. Oxford

Osmond, J., Turner, A. & Land, R. (2007) '"hreshold Concepts and Spatial Awareness in Automotive Design". In Land, R., Meyer, J. and Smith, J. (eds) *Threshold concepts in the disciplines.* Rotterdam: Sense Publishers.

Ramsden, P. (1992) *Learning to Teach in Higher Education*. London: Routledge.

Ritterman, J. (2010) "Riding the Tiger: Leading institutions for higher education and the arts at the beginning of the twenty-first century" in Corcoran, K., Delfos, C, Solleveld, F. (eds) (2010) *ArtFutures Current issues in higher arts education*. Amsterdam. December. [Cited 29 October 2012] Available from: http://www.elia-artschools.org/News%2B/ArtFutures+-+Current+issues+in+higher+arts+education.

Said, E.W. (1991). *Orientalism: Western Conceptions of the Orient*. Penguin, London.

Tovey, M., Bull, K., Osmond, J. (2010) "Developing a Pedagogic Framework for Product and Automotive Design". *Design & Complexity Conference. Université de Montréal.* July

Submission [10]

Bull, K. and Osmond, J. (2013) 'Design Education and non-EU students: shifts in teaching practice'. *DRS//CUMULUS Oslo 2013 Proceedings*. Oslo. 14-17 May. Volume 1: ISBN 978-82-93298-01-4

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Design Education and non-EU students: shifts in teaching practice

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Abstract: *The number of UK international HE students has gradually increased over the last decade, in particular the number of non-EU Chinese and Indian students. This influx has resulted in the recognition that exposure to an unfamiliar pedagogical cultural habitus can cause problems, often compounded by language problems. This paper outlines the response of an MA teaching team at Coventry University to misconceptions that a cohort of Chinese and Indian students expressed during a research methods module. This was evidenced by uncertainty as to what they were expected to produce in terms of a research proposal, as the extension of the boundaries of creative thinking necessary to tackle 'wicked problems' seemed beyond their capabilities. This echoed previous undergraduate research, which surfaced a threshold concept, 'the toleration of design uncertainty'. Using this as a baseline, the teaching team shifted from a sequential method of teaching, towards a much more conceptual mode, underpinned by use of visual tools and a greater emphasis on group collaboration. These innovations are now been embedded within the curriculum, and early indications are that students are much more engaged and confident in the embracing of research territories: the innovations have also been introduced across the whole MA curriculum.*

Keywords*: Internationalisation, Masters Course, design education, design education methods*

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Introduction

The number of international students studying in the UK has gradually increased over the last decade, in particular the number of non-EU students. According to Universities UK (2011), the numbers have more than doubled, and there was an increase of 11.7% between 2009 and 2010.

Further, according to UKCISCA (2012), there were 298,000 non-EU students in 2010-11 and of these the majority (43%) were postgraduate taught students (followed by first degree students at 38%), with the top non-EU sending countries being China and India (67,000 and 39,000 respectively). China (excluding Hong Kong, Taiwan and Macao) provided the second highest number of students for postgraduate taught courses, and India the highest. (Universities UK 2011)

This large representation of Chinese and Indian students in the non-EU student figures, particularly in taught postgraduate courses, is reflected in the experience of Coventry University, in relation to industrial design Masters and MSc courses. In 2011/12, of the 37 students on the course, 14 were from China and 13 from India; in the current academic year, the figures continue to show dominance in terms of Asian students, comprising 24 out of 31.

The preponderance of Chinese and Indian students on a creative arts course perhaps reflects the recognition of the link between creativity, competitiveness and global marketplace success. This is a link that the UK has long recognised with the consequent need to focus on and develop this to enable UK competitiveness within a global marketplace (HM Treasury 2010).

However, it seems that the Asian hemisphere has also recognised that creativity and innovation is crucial to its success on the world stage, and has thus established a renewed focus on the development of creative thinkers. Specifically, in China the focus is on educational courses that feed and develop its creative industry (British Council 2012) and in India the pedagogic focus has moved from rote memorisation to conceptual understanding (Stewart 2009).

But, despite any changes in their educational systems, all non-EU students will still have to make adjustments within an unfamiliar pedagogic culture or habitus (after Bourdieu 1989), when they arrive in Western Universities. For Carroll and Ryan (2005) this means that they have to face “different social and cultural mores and customs, norms and values from the ones they have known; different modes of teaching and learning; and different expectations and conventions about participation and performance”. This is echoed by Kutieleh and Egege (2004), who highlight the depth of cultural shift required by international students and indicate that many Western rooted educators act on an implicit cultural assumption that critical thinking is core to good thinking but unintentionally overlook that this is not rooted in most Asian education systems.

Linked to the lack of embedded critical thinking within the curriculum is the reluctance by many Asian students to interact within the classroom. For Chinese students, this is thought to be related to the power-distance dimension – the further away from the source of power a learner is, the more powerful the teacher is, and vice versa. In Western cultural pedagogy, there is a low power-distance, so students are expected to question, criticise and interact with teachers; in contrast, Chinese students see the teacher as a source of knowledge with a responsibility to lead sessions. This is seen as the Confucius educational model which is based on “respect for authority and

consensus seeking and collectivity" (Hongsong 2007:3), and is therefore "fundamentally didactic"(Beck et al 2009).

Similarly, India's National Institute for Design recognises that its initial task in relation to its undergraduate students is to "nullify the pedagogical shock by making the [undergraduate] student unlearn old things and old ways that are carried with them into higher education from a system that is an over structured, didactic, rote routine restriction type". (Balaram 2005:16).

This adjustment to a different cultural pedagogy is perhaps especially difficult when non-EU students enter a creative discipline which privileges individual agency as a core part of its curriculum. Thus, the unfamiliarity with both pedagogic culture, and a concomitant discipline freedom can negatively impact non-EU students' ability to manage the transition from a more structured educational habitus towards coping successfully with an open brief environment.

This unfamiliarity was reflected in data gathered from a longitudinal study carried out between 2005 and 2010 by Coventry University's Centre of Excellence for Product and Automotive Design (CEPAD), which identified 'the toleration of design uncertainty' as an undergraduate threshold concept. Threshold concepts are defined by Meyer and Land (2003) as:

> akin to a portal, opening up a new and previously inaccessible way of thinking about something...a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress.

This identification of the 'toleration of design uncertainty' (Osmond et al 2010) - defined as the moment "when a student recognises that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process'"- led to a redesign of the undergraduate curriculum in 2010. The focus is now on the provision of safe spaces for industrial design students within which they can experience the intense uncertainty that is a routine part of the design process.

Part of the longitudinal study also involved interviewing international students who outlined how different the open brief environment was from their previous educational experiences. Therefore, the international students seemed to find the negotiation of the journey through an uncertain and unsafe creative space more problematic than domestic students, as many of the former had not already experienced such spaces in their previous educational background.

This has also been reflected more recently with a cohort of non-EU Masters level students. This necessitated both local analysis of the pedagogic approach and a consequent shift in teaching practice within a module focusing on design research activity.

For Wagner *et al* (2011) there is currently no pedagogical culture established in relation to teaching research methods, especially from a critical and creative perspective within higher education and, taken on an institution-to-institution basis, the status and functions of those that teach design research "vary widely". As well as arguing for a widespread debate on this subject, Wagner et al also argue that understanding what students' conceptions of research are can allow a "more carefully targeted pedagogy".

This is reflected by Farfán *et al* (quoted in Wagner) in that understanding what students' conceptions of research are is even more essential as they recognise that there is a challenge inherent in teaching students "whose epistemologies differ

significantly from those that dominate the research paradigm of most methods courses".

The need to support international students reinforces this debate about the structure and techniques for imparting a critically centred design research approach.

The following case study illustrates some instances of unfamiliarity with a Western cultural pedagogy and consequent misconceptions in terms of design research methods that both Chinese and Indian students expressed during Masters level industrial design modules. These misconceptions resulted in the initial teaching strategy being reshaped and the acknowledgment that the threshold concept identified for undergraduate students now has some currency in informing future curriculum design for non-EU students.

Methodology

The focus was on 14 Chinese and 13 Indian students undertaking an MA Research Methods module during the 2011/12 academic year. The research goal 'How can we enhance critical and creative design thinking abilities with international cohorts' were to be achieved through interventions, evaluation, key observations and outcomes as detailed in Figure 1.

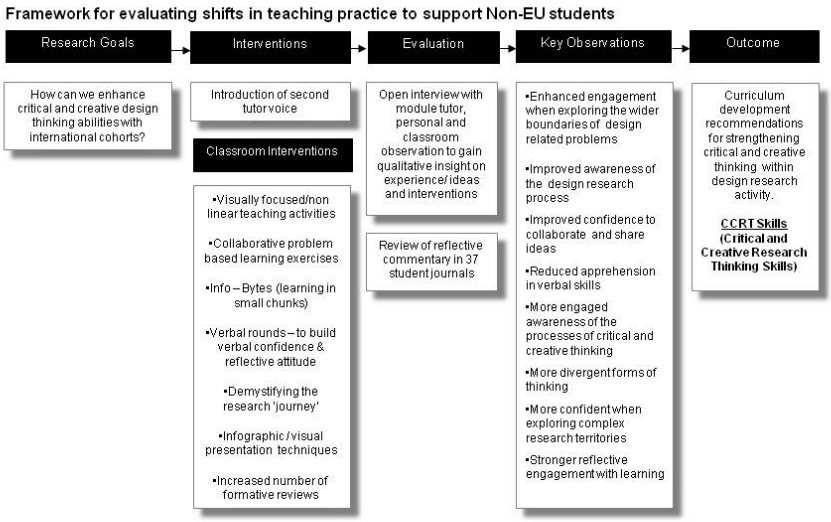


Figure 1:Framework for Evaluation

Teaching Design Research to Postgraduate Students

This case study explores the experience of a postgraduate teaching team in the Industrial Design Department of Coventry University that were tasked, in 2011/12, with facilitating design research thinking with a Master level cohort predominately made up of non-EU students. It was the first experience of this teaching team working with an almost entirely international cohort on these modules.

The aim of the teaching is to get the students to creatively engage with the research process and so they are expected to identify a research problem and frame a feasible

proposal that is likely to lead to a strong design 'innovation angle' to inform well evidenced design activity. The process is centred on generating a self-defined problem/opportunity informed by in-depth research to propose a design solution, manifesto or guideline that is creative, innovative, socially relevant and intellectually challenging.

The course sits over a traditional undergraduate degree course in product or transport design and aims to equip graduates to operate successfully as visionary design strategists, design managers, consultants and interdisciplinary contributory thinkers who have the skills and imagination needed to effect real change through design. In other words, the aim is to help students to "think big" (Brown, 2009), act as design thinkers and challenge existing preconceptions about the problems and opportunities of the world and its societies. This skill is potentially important at all levels of the design process, from identifying strategic opportunity, through to ensuring good understanding of customer experience (Hunter 2012).

The design research teaching is structured in two phases (Figure 1). Firstly project formulation which then, secondly, leads into a final major project. These phases are complemented by a whole range of other modules that engage students in learning surrounding the critical and creative design process and its related activities and skills development.

As the first term progressed, the teaching team became very concerned about the challenges students faced. Commonly for example, Chinese and European students had had a very strong design practitioner training, but Indian students tended to be from an engineering or business background and thus had very logical mind-sets and saw researching as a highly procedural activity with little appreciation of context. Many of them found written English a challenge and referencing a very difficult concept, which seemed strongly linked with cultural tradition and practice. To begin the module students are required to bring a problem/opportunity to the teaching team for discussion. This proved to be the most challenging phase of activity and one that centred around the framing of a research question and definition of a research territory – often recognised by the tutors as a 'troublesome activity'. Many of the students had never had to independently formulate their own research question or problem statement before, as prior teaching had evidently been centred around 'given' objectives.

It was also apparent that while international students are often very comfortable with desk-based research, they found the "wicked problem"(Buchanan 1992) nature of design research a challenge as it is in a highly empirical and inductive research domain.

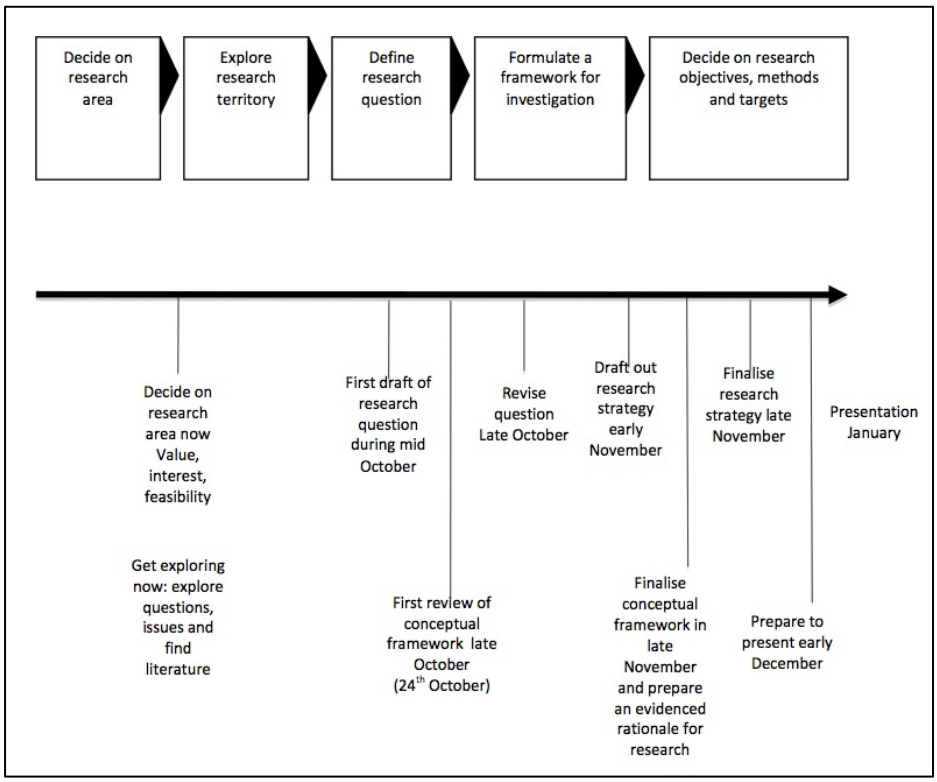


Figure 2:Example framework for completing the project formulation phase

As such this was often outside many of the students' more natural engagement with deductive forms of research and analysis. The inductive exploration of research objectives (Figure 2) was often very uncomfortable for the students, leading to much uncertainty and appearing 'needy' as a result of not having clear boundaries or solution focus. Confidence to engage with research arguments proved to be a central challenge for students and echoed 'the toleration of design uncertainty' undergraduate threshold concept identified previously by CEPAD.

Therefore, whilst many of the students understood the creative boundaries of tackling a design brief by researching around a given set of constraints, they were less able to operate successfully when there were none and only a problem territory to explore. It seemed difficult to explain to the students the key focus of the major project - to put across a 'design argument' centred around often tacit and/or intuitive starting points about design and problems of the world. To encourage confidence with more experiential forms of design, the students were strongly encouraged to select research areas that were quite personal to them, for example, sports, music, personal interests, as it was thought likely that their experience of these subjects would make it more 'natural' for them to explore on a more holistic and intuitive level. Value metrics were introduced to help the students recognise the value of their own experiences as a potential project starting point. However one student often apologised for having a project she was passionate about, thinking that in some way this was a negative basis for a project.

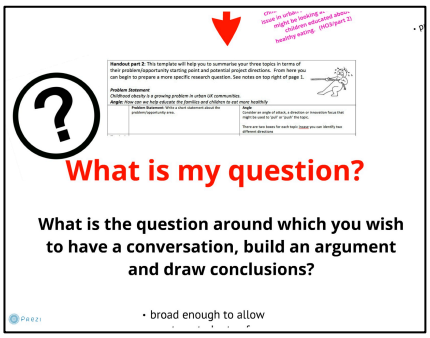
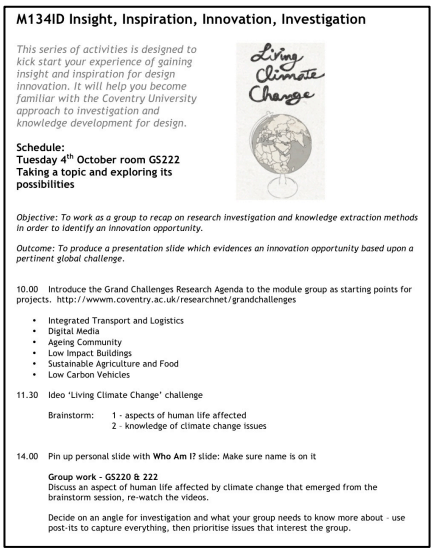


Figure 3: Sample screen from 'Exploring Research Territory' lecture

This difficulty was exaggerated by significant classroom challenges in getting students to speak out in a seminar situation, especially in relation to project progression. Teaching methods initially comprised lectures with groups of 37 with scope for activities and questions (Figure 3). Often it took much effort by the tutor to facilitate an engaged conversation from more than a few students, and break-out cross-cultural groups seemed difficult to achieve. By the end of the first term it was evident that the Chinese students tended to stick together, with only one or two people speaking on their behalf. Consequently, the tutor was uncertain as to how much the students were in fact understanding the lectures, and the result was fairly disappointing module results at the proposal stage. Meanwhile the Indian students appeared confident in speaking independently and held strong viewpoints, but these viewpoints were often lacking a 'depth of evidence' This necessitated a number of students having to redirect their project foci.

After the challenges of the first term which was mainly lecture/seminar driven, a second tutor who specialised in critical and creative thinking joined the team. Immediately the advantage of having a second voice bringing a much more discursive teaching style: having a shared perspective in the teaching team enabled strong self-analysis of the teaching approach and many ideas for classroom intervention.



M134ID Insight, Inspiration, Innovation, Investigation

This series of activities is designed to kick start your experience of gaining insight and inspiration for design innovation. It will help you become familiar with the Coventry University approach to investigation and knowledge development for design.

Schedule:
Tuesday 4th October room GS222
Taking a topic and exploring its possibilities

Objective: To work as a group to recap on research investigation and knowledge extraction methods in order to identify an innovation opportunity.

Outcome: To produce a presentation slide which evidences an innovation opportunity based upon a pertinent global challenge.

10.00 Introduce the Grand Challenges Research Agenda to the module group as starting points for projects. http://wwwm.coventry.ac.uk/researchnet/grandchallenges

- Integrated Transport and Logistics
- Digital Media
- Ageing Community
- Low Impact Buildings
- Sustainable Agriculture and Food
- Low Carbon Vehicles

11.30 Ideo 'Living Climate Change' challenge

Brainstorm: 1 - aspects of human life affected
2 - knowledge of climate change issues

14.00 Pin up personal slide with **Who Am I?** slide: Make sure name is on it

Group work - GS220 & 222
Discuss an aspect of human life affected by climate change that emerged from the brainstorm session, re-watch the videos.

Decide on an angle for investigation and what your group needs to know more about - use post-its to capture everything, then prioritise issues that interest the group.

Figure 4: Example of an early task set to promote team working and creative topic exploration

For example, it was identified that it would really help to get a better balance between traditional PowerPoint-led lectures and non-sequential delivery which focused more flexibly around problem definition, framing of research, methods, analysis of results and planning: in short, a visual and discursive teaching method was employed to help promote understanding. This was in contrast to the initial goals which were linear and straightforward in approach in order to support language confidence. To implement this new approach the team put together a programme of critical and creative research technique skills through visual tools such as short videos and Prezi presentations combined with practical activities such as drawing out research journeys. (Figure 4).

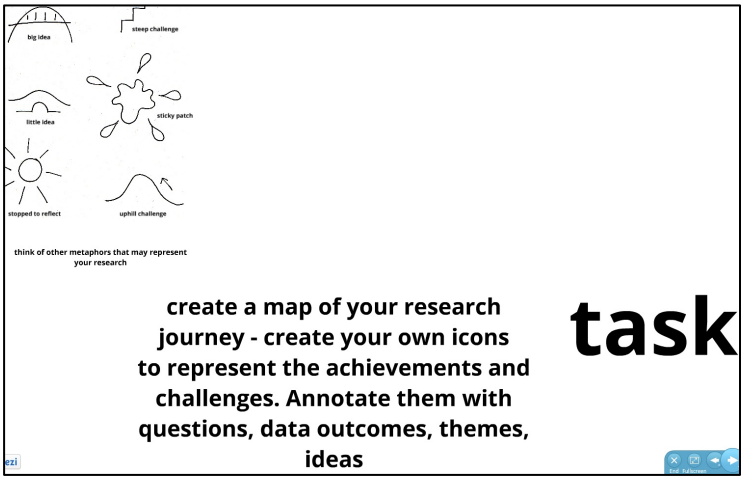


Figure 5: Screen shot of a seminar task delivered via Prezi

Prezi is a free cloud-based presentation tool in the form of an open canvas that can be explored in a much more spontaneous way than PowerPoint. A path of content can be followed but allows emphasis and exploration of the presentation space. The prioritisation of content according to the different emphasis needed can be specified - for example, the ability to hide detailed text, whilst at the same time allowing large and visible key prompts throughout the presentation. For the teaching team this provided a way of presenting explorative materials and concepts and thus enabled a more holistic way of expressing 'thinking styles' and critical and creative approaches to research. In short, the team aimed to move out of the procedural and into the conceptual levels of engaging with design activities. Short videos were also used, such as YouTube movies, tutor blogs and lectures that utilised graphic examples and other media to explain how data might be drawn together or explored. Another activity introduced was a lecture called 'research by metaphor' which was designed to get students to understand the approach as a 'journey of discovery'. (Figure 5).

To support this the students were introduced to methods of presenting information in the form of iconographics to help them transform research data and explain ideas in fewer words. This proved useful in explaining complex terms in a more universal language. This also aimed to support the preparation of research posters that evidenced the students' thinking processes. London-based author, data journalist and information designer David Candless's[1] work was referred to in order to encourage the students to appreciate that complex information can be designed.

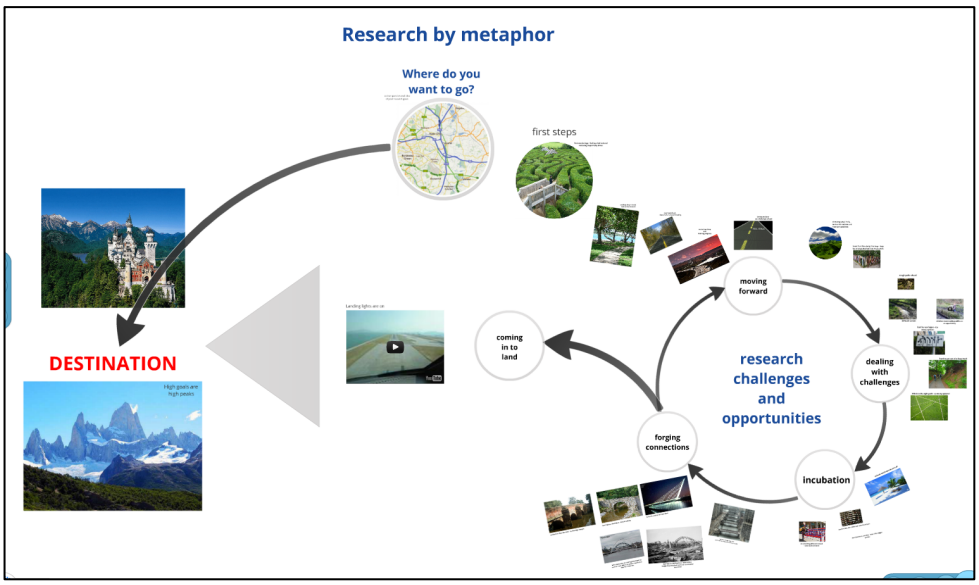


Figure 6: Research by Metaphor

Alongside this were scaffolded verbal presentation activities which aimed to gradually improve the student's comfort zones when presenting in front of colleagues. This was especially pertinent in relation to challenging research concepts and

[1] http://www.davidmccandless.com

arguments where students lacked confidence to speak on a subject that was often inductive or contextual in nature. Thirty-second round-room individual presentations were organised and over the weeks built up to full length 'mock vivas'. It was felt that this approach also encouraged a more reflective attitude to learning and from the second term the student voice became central to activities. For example, the students were asked to express their personal learning experiences and design knowledge and analyse texts to highlight themes and make connections. In other words, the students, both individually and in groups, were encouraged to deconstruct and verbally present their views.

Over the year the idea of group debate become more dominant in the teaching approach and helped the students not only grow their confidence, but also put their own research into an 'active space' (rather than a 'step-by-step' procedural space).

As the major project progressed into its final weeks there seemed to be an 'enlightenment moment' where students suddenly became more engaged in seeing the opportunities and thinking more creatively about the research outcomes, although it is acknowledged that one motivating factor may have been the added element of time pressure.

One example of this involved a Chinese student who initially focused his study on the limited scope of using a memory stick (Figure 6), but eventually engaged with the critical challenge of exploring how to capture and interact with digital memories, and went on to produce a future concept for a gesture-controlled product that helps to store, recall and interact socially with memories (Figure 7)

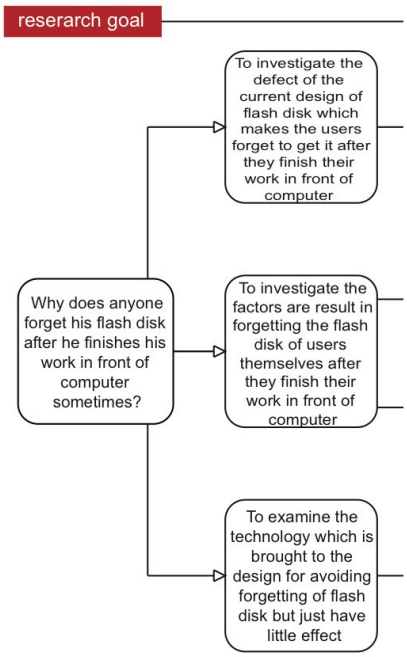


Figure 7: Initial student proposal which lacked a critical approach.

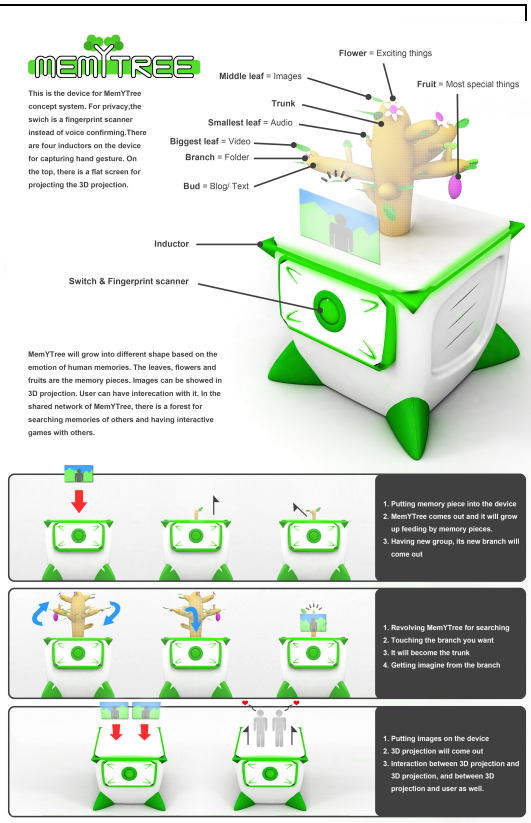


Figure 8: Final proposal which has a deeper level of critical engagement

The following feedback from the students at the end of the major project module reinforces that the shift in teaching practice from a procedural model to a more discursive and visual approach, did enable many of them to embrace more deeply the critical and creative design thinking processes.

> I began to recognise that research was not just a collecting process, but one of analysis with one's own data.
>
> One thing about Chinese education is that we are taught with the same skills that teachers have. But here, the teaching goal is to let people find themselves in every subject. It paid more attention to the creative part and how to shape those fancy ideas into the real stuff.
>
> Before this, I thought that the ideas which came from the human head could be a little different from each other. It really shocks me when I compared the ideas from my French classmate with my Chinese classmates: I have to say I am inspired by those wonderful ideas.
>
> Before, I would treat any lamp as what it is. A tool we need in the dark, maybe gives it some beautiful form to let it be romantic. And that is it, closed the question. But now, I learned to look at it in different aspects. Now, my brain would give me crazy ideas like: if the goal is to see things clear why use lamp, we could use several other

ways to fulfill that needs. How about using supersonic wave? How about glowing objects? How about changing the range of eyes' adjustment?

As I started progressing in my research I've learnt to continuously ask 'Why' at different levels. This has enhanced my reasoning capabilities. Internet, Books, inside and outside experts helped me propel through my research. The library started becoming my second home.

This project has enriched my way of thinking and helped me to realize the importance of research process which I have regrettably underrated during my previous projects. It also forced me to overcome the apprehension of talking to people in a foreign language and thus improved my self-confidence.

The approaches outlined above have now been integrated into the very start of the new academic year – particularly those that encourage group based object analysis on artworks in the city, in order to get students speaking out very quickly about ideas and potential research challenges. To begin with a one-week intensive set of workshops were introduced aimed at getting students to talk to each other, work collaboratively and explore problem/opportunity contexts to form the basis of new research questions. Now four weeks into teaching the 2012-13 cohort, the teaching team are seeing much more engaged and confident embracing of research territories.

Conclusion

As outlined in the introduction to this paper, there is evidence showing that within this module, the Chinese and Indian students experienced problems with an unfamiliar cultural pedagogy/habitus in relation to an initial sequential teaching method.

The teaching team identified challenges in relation to dealing with framing and engaging with ill-defined problems, and they also recognised that the students often had a very different power-distance dimension, in comparison to domestic students. This necessitated considerable engagement strategies in order to help them embrace a western model of design thinking whilst building on their own specialist and cultural foundations.

It was also recognised that the students had one challenge in common – the extension of the boundaries of creative thinking - from solution focused to problem focused. This is the area that students did not appreciate, as it seemed 'wicked problems' as a concept was beyond their experience base. In essence, whilst the students with design experience understood the mechanisms of basic creativity for design exploration, they found the concept hard to translate into a wider problem-solving context. This was evidenced by uncertainty as to what they were expected to produce in terms of a research proposal: therefore, when presented with the freedom to set their own research focus, the students struggled to formulate this, despite efforts being made to encourage them to focus on personal experiences.

This difficulty was compounded by a reluctance to speak out in the classroom, with the Chinese students tending to rely on one 'spokesperson' to carry out this function. For the Indian students, although they were confident in speaking out, when they did so the result was a lack of deeper understanding of the subject matter. Thus, collaboration was also at the heart of this challenge: different cultural and educational values required the teaching team to work at engaging students in a collaborative

dialogue about their research territories. Other problems included lack of proficiency in written English and unfamiliarity with referencing.

To tackle these problems, the teaching approach was revised to focus on a much more conceptual delivery, and thus moved away from a step-by-step process, which, it could be argued, was what the students were familiar with and did not help them to break away from a method that does not lend itself to creative and conceptual thinking. This conceptual delivery was underpinned with a strong focus on visual materials in the form of a presentation system that encourages 'mind mapping' and other visual tools - such as short videos, YouTube movies, tutor blogs, iconographics and lectures that utilised graphic examples. Another innovation was a much stronger focus on debate style classroom activities, in particular thirty-second round-room individual presentations, which built up to full length 'mock vivas'.

As a result of the changes, the teaching team did identify a leap in capability at the end of the year, helped by regular formative review points introduced for the last six months of study which involved submitting aspects of learning outcomes. These review points were aimed at supporting language difficulties, helping the students to build their research argument and trying to avoid problems such as plagiarism. In essence the teaching team offered in depth feedback through audio and written media as it was felt that this combination gave the students media that might be better suited to varied levels of English language comprehension.

The main pedagogic goal that the teaching team has taken away from this case study is the need to engage students early on with reflective tasks that allow them to build upon their cultural and discipline core with the experience of critically and creatively challenging problem contexts. This is to help students believe that they have valuable interests and experiences that provide good starting points for embracing intuitive and inductive research, and also help the tutors to better understand the students' experiences of learning.

Although there is much to do and much to learn in order to support the cultural and discipline richness of the student groups, the approach has been to focus on making intervention across the whole programme - rather than just the research modules - in order to embed a collaborative and integrative culture that has critical and creative challenge at its core.

Finally, the teaching team's recognition that the students' struggle with creative and conceptual thinking was linked to the undergraduate 'toleration of design uncertainty' threshold concept was useful in framing the curriculum intervention. That this undergraduate threshold concept has also been evidenced with Chinese and Indian international students seems to point to the importance of previous educational backgrounds in the design field and how this can shape how students cope with the conceptual and critical thinking that allows them to test their own creative boundaries and thus build up the confidence to challenge design conventions.

References

Balaram, S. (2005) "Design Pedagogy in India: A Perspective". *Design Issues*. Volume 21, Number 4. Autumn

Beck, A., Bull, K., McCartan, S. (2009) "English Corner: fostering international student collaboration through e-learning technologies". *International Conference on EPDE*. Brighton University. September.

Bourdieu, P. (1979) *Distinction: A Social Critique of the Judgment of Taste*. Cambridge, MA: Harvard University Press

British Council (2012) ”SINO-UK HIGHER EDUCATION COOPERATION ON CREATIVE MEDIA INDUSTRY”. [Cited 29 October 2012] Available from: http://www.britishcouncil.org/china-education-higher-media.htm

Brown, T. (2009) ‘Tim Brown urges designers to think big’ TED: ideas worth spreading. [Cited 28 October 2012]. Available from: http://www.ted.com/talks/tim_brown_urges_designers_to_think_big.html

Buchanan, R. (1992) ”Wicked Problems in Design Thinking”. *Design Issues*. Spring. V8 No2

Carroll, J. and Ryan, J. (eds) (2005) *Teaching International Students – Improving Learning for All*. Abingdon, Routledge

HM Treasury (2010) *The Cox Review of Creativity in Business*, [Cited 28 October 2012], Available from:: http://www.hm-treasury.gov.uk/coxreview_index.htm

Hongsong, S., Barton, W., Burns, J. (2007) ”Socrates Confucius and Me: Pedagogic Responses to different scholarly traditions in China and the UK”. *Keynote address ELATE Conference, Coventry University*. June.

Hunter, M. (2012) *What Design is and Why is Matters*. Design Council. [Cited 28 October 2012] Available from: http://www.designcouncil.org.uk/about-design/What-design-is-and-why-it-matters/

Kutieleh, S., and Egege, Y. (2004) ”Critical thinking and International students: A marriage of necessity”. *First Year in Higher Education 2004 Conference: Dealing With Diversity*. 8th Pacific Rim Conference.

Meyer, J. and Land, R. (2003) ”Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising within the disciplines”. *Occasional Report 4*. [Cited 28 October 2012] Available from: http://www.etl.tla.ed.ac.uk/publications.html.

Osmond, J., Turner A. (2010) ”The Threshold Concept Journey: from identification to application”. In JHF Meyer, R. Land & C. Baillie, eds. *Threshold Concepts and Transformational Learning. Sense Publishers*. Rotterdam.

Stewart, V. (2009) ‘Expanding Secondary Education in India’. [Cited 28 October 2012] Available from: http://www.cerium.ca/IMG/pdf/Expanding_Secondary_Education_in_India-1-.pdf

UKCISA (2012) ‘International students UK higher education: Key statistics’. . [Cited 28 October 2012] Available from: http://www.ukcisa.org.uk/about/statistics_he.php [28 October 2012]

Universities UK (2011) ”Patterns and Trends in UK Higher Education 2011”. [Cited 28 October 2012] Available from: http://www.universitiesuk.ac.uk/Publications/Documents/PatternsAndTrendsinUKHigherEducation.pdf/

Wagner. C., Garner, M., Kawulich, B. (2011) ”The state of the art of teaching research methods in the social sciences: towards a pedagogical culture”. *Studies in Higher Education*. 36/1/75-88. SRHE